

# Current Science



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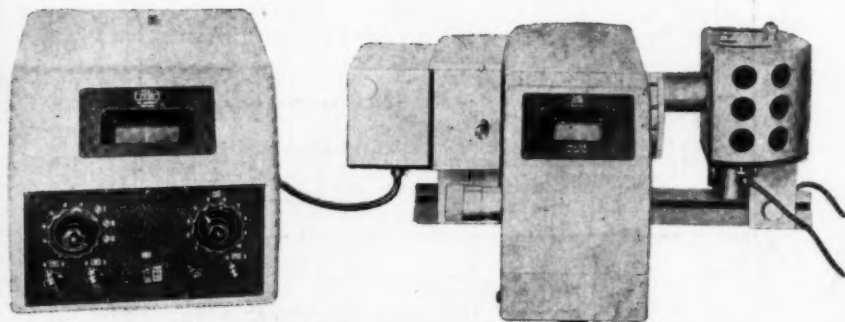
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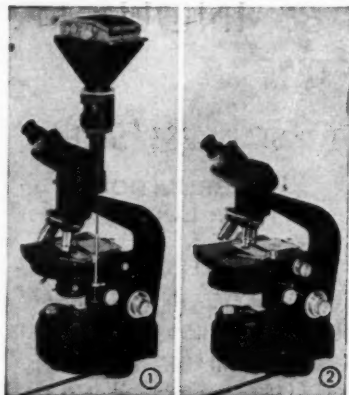
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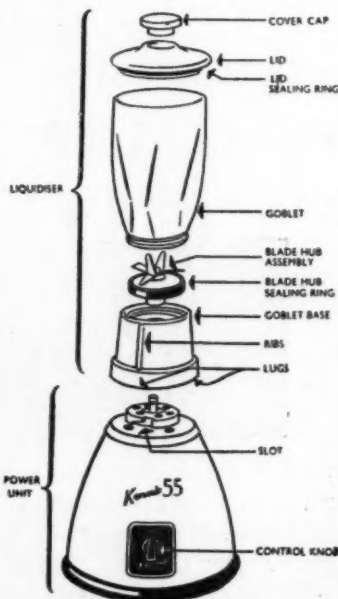
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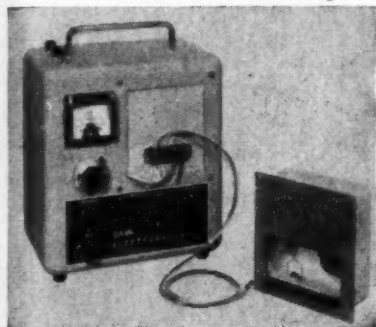
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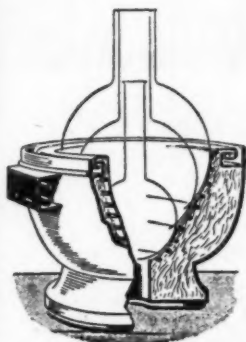
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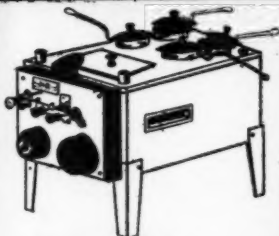
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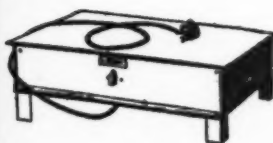


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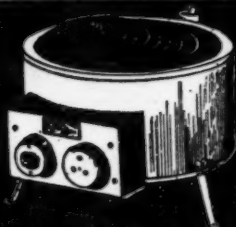


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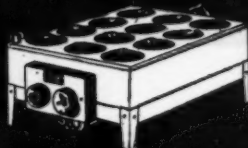


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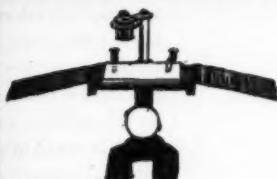


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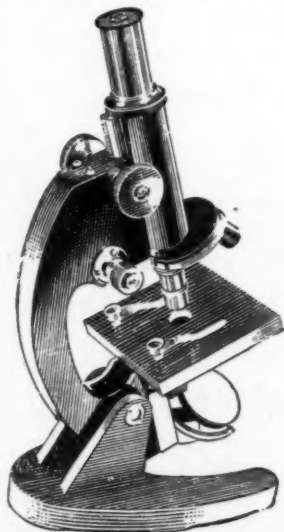
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## CHRISTIAAN HUYGHENS AND THE WAVE THEORY OF LIGHT: Part II

SIR C. V. RAMAN

### 5. THE WAVE-OPTICS OF HUYGHENS

BEFORE proceeding to comment on the writings of later authors on the work of Huyghens, we may usefully here summarise the basic concepts of his theory. Huyghens put forward and sought to establish the proposition that when a wave of light diverges from its source, every small portion of the wave is capable of propagating itself independently with the same velocity as the rest of it; in an isotropic medium, the direction of such propagation is the wave-normal and hence this is also the direction of the ray in the sense of geometrical optics. The same idea forms the basis of Huyghens' explanation of the reflection and refraction of light. When the elements of area of an advancing wave-front reach the boundary between two media, each such element gives rise, respectively in the two media, to the elements of area in the reflected and refracted waves. These latter advance normally to themselves in such a direction that they can join up and form continuous wave-fronts. The geometric constructions employed by Huyghens enable these requirements to be satisfied. The propagation of light in an inhomogeneous medium considered in the fourth chapter of Huyghens' treatise can also be very simply dealt with on the same basis. The elements of area of the wave-front in such a medium advance normally to themselves with the velocity appropriate to their positions in the medium. As they advance, they join up to form new wave-fronts which are orthogonal to the path of the light-rays in the medium.

Later writers have criticised the arguments employed by Huyghens in his treatise. One remark which is often made is that the theory of Huyghens would result in his wave-fronts moving backwards as well as forwards and that he had given no explanation for the absence of backward propagation. But this criticism is not justified and is itself based on a misunderstanding. Huyghens was concerned with the behaviour of an *advancing* wave-front in a homogeneous medium. The partial waves which in his theory give the observed light intensity by their superposition are those which diverge from points lying on the straight line between the source and the observer; in order to reach the observer simultaneously they should all move *away* from the source and *towards* the point of observation, in other words move

forwards towards the observer. The possibility of backward propagation is thus ruled out completely.

Another criticism which has frequently been advanced is that the theory of Huyghens is based on an arbitrary assumption, *viz.*, that only along the envelope of his partial waves would there be any observable intensity of light. This criticism is also based on a misunderstanding. It should be remembered that Huyghens was unaware that the waves of light are periodic disturbances having a definite wave-length. He assumed that light consists of *individual* waves which diverge in all directions from the original source and the partial waves contemplated in his theory would therefore also be of the same nature. The build-up of a finite intensity from the superposition of a very large number of such waves, each of which is extremely feeble, would accordingly be possible only if they arrive *simultaneously* at the point of observation. The diagram appearing in the first chapter of Huyghens' treatise is intended to assist the reader to appreciate the arguments set out in the text; *viz.*, at each point on the wave-front a great number of partial waves arrive *simultaneously* and build up the intensity at that point, while the entire wave may be itself considered as made up of a great number of elementary areas at which the light-intensity has thus been built up. In the later chapters in which Huyghens' theories of reflection and refraction and of the propagation of light in an inhomogeneous medium are expounded, the diagrams are intended to exhibit how the complete wave-front arising from these processes is built up out of its elementary parts or areas. Here again, the final result is an individual wave, and it may therefore be correctly described as the envelope of the partial waves which co-operate in building it up.

### 6. THE PARTIAL WAVES OF HUYGHENS

Since the concept of partial waves introduced by Huyghens in his treatise has played an important role in physical optics, it is appropriate that we consider it here in some detail. Though the words appear in several chapters of his treatise, it should be remarked that they do not have the same significance in each case. In the first chapter which seeks to explain the rectilinear propagation of

light, the partial waves arise as a consequence of the assumed discrete structure of the luminiferous medium; each particle in the medium is regarded as a source of such waves. In the second and third chapters, the partial waves are assumed to arise when the primary wave reaches the boundary separating the two media with different properties. The elements of area of the boundary are here regarded as the source of partial waves. Since they travel with different velocities, they are distinct from each other in the two media. In the fourth chapter which deals with the propagation of light in inhomogeneous media, the partial waves are assumed to diverge from the elements of area of the advancing wave-front in such a medium.

If the luminiferous medium were empty space, the assumption that it consists of discrete particles which can function as emitters of partial waves would be difficult to justify. In the case of material media, however, there is good reason for assuming that the discrete atoms of which they are composed could function as sources of secondary or partial waves. Even so, however, these partial waves would reinforce each other in the direction of propagation of the primary wave and merge with it, while in other directions they would interfere and cancel out each other's effects. Thus, they would, in all cases, cease to be observable. Accordingly, the notion of partial waves can, in such circumstances, be regarded only as hypothetical or virtual and not as an observable or physical reality. The same remarks would also be applicable in regard to the propagation of light in a medium which is inhomogeneous. Indeed, as already remarked, this particular case could be dealt with in a very simple manner without making any use of the concept of partial waves. Thus, finally, we are left with the phenomena arising from the incidence of light on the boundary between two material media. Huyghens' construction explains the geometric laws of reflection and refraction in so natural and convincing a fashion that it is difficult to resist the conclusion that his concept of partial waves is well-grounded and is a physical reality in these particular cases.

## 7. THE SO-CALLED PRINCIPLE OF HUYGHENS

It will be evident from what has been said above that the ideas of Huyghens were not correctly understood or appreciated by later writers. It is not surprising therefore that the whole of the vast literature which was subsequently published and which claims to base

itself on the ideas of Huyghens, in reality proceeds on a different basis altogether. This is evident from the fact that the mathematicians whose objective was to develop a "Rigorous Formulation of the Principle of Huyghens" concerned themselves with precisely the case in which Huyghens' concept of partial waves has no physical meaning or justification, namely the undisturbed propagation of waves from a source situated in a structureless and uniform continuum.

The well-known formula developed by Kirchhoff is an illustration of the foregoing remarks. Here, the disturbance due to the source at the point of observation is expressed as an integral taken over the area of a closed surface within which the point of observation is included but not the source. Each elementary area of the surface appears in the formula as a source from which waves diverge with amplitudes which vary with the direction of emission. The line joining the source and the point of observation is also the direction of maximum amplitude for the waves radiated by the element of area which lies on that line between them, and of zero amplitude for an element of area which also lies on the same line but on the opposite side. Kirchhoff's formula as actually developed refers to the case of sound-waves, and the attempts made to extend it to the case of light have not met with success. But our present concern is not with the mathematics of the formula but with the physics of the subject. The association of the formula with the name of Huyghens—honoured as the founder of the wave-theory of light—has naturally disposed whole generations of physicists to look upon it with favour. It has, however, been made clear by the foregoing remarks that Kirchhoff's approach to the subject is quite different from that of Huyghens. We have, therefore, to ask ourselves: Is Kirchhoff's formula really meaningful? Has it any claim to validity or acceptance considered from the standpoint of optical theory? We shall proceed to consider these questions.

As has already been remarked, one of Huyghens' striking successes is his explanation of the geometric laws of reflection and refraction. His concept of partial waves takes its clearest and most acceptable form in this case, viz., that each element of area of the physical boundary acts as a source of partial waves. Since these move with different velocities in the two media, they should be considered as

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distinct. In other words, the partial waves in each medium are hemispherical, and it becomes a meaningful physical problem to determine the dependence of the amplitude of the waves with direction on the surface of these hemispheres. It would presumably be a maximum in the direction of the normal to the boundary and zero in directions parallel to the boundary. On the other hand, the very generality of Kirchhoff's formula indicates that it has no physical validity or significance. For, it is not possible to discover or assign any reason why an element of area set at an arbitrary orientation

in a continuous structureless medium should function as a source of secondary waves with specific features related to that orientation. If the concept of partial or secondary waves is at all to be meaningful, the waves should have a physically recognizable origin, e.g., a local discontinuity in physical properties. In its absence, the formula ceases to have any physical content. Kirchhoff's formula thus reveals itself to be a mathematical abstraction which is not relevant or valid in relation to the actual problems of physical optics.

### LUNAR CRATERS CAUSED BY COMETARY COLLISIONS

THE reported observation by Kozyrev of emission bands of carbon molecule in the lunar crater Alphonsus [see *Curr. Sci.*, 1958, 27 (12), 512 and 1959, 28 (2), 93] has reopened the age-old problem of the origin of lunar craters and lunar plains, and the dilemma between the volcanic and impact theories of their origin confronts us in a new form. Zdenek Kopal suggests (*Nature*, 183, p. 169, Jan. 17, 1959) that any theory of lunar surface features restricted to a consideration of impacts of solid bodies only is bound to remain seriously incomplete, and should be generalized by taking account of the effects which could be wrought on the lunar face by collisions with cometary heads.

According to the impact hypothesis most lunar craters were formed by solid bodies (meteorites, or asteroids) impinging on the Moon with cosmic velocities. It has been calculated that kinetic energies of the order of  $10^{28}$  ergs are necessary to produce impact craters of 80 miles in diameter (like Alphonsus). Such an impinging solid would penetrate at least a few hundred yards into the lunar crust before total vaporization and ejection of crater walls by explosion. This would produce a "moonquake", characterized by a very shallow epicentre, with about one half of the kinetic energy converted into seismic waves.

The latest survey of earthquakes shows that the largest and the most destructive of them experienced so far entailed an energy release of  $10^{25}$  ergs only—i.e., one thousandth of the hypothetical 'moonquake' which might have

caused Alphonsus crater. Considering that there are of the order of  $10^5$  craters of diameter varying between one mile and 150 miles on the visible half of the Moon alone, it is difficult to explain how any steep mountains or ridges anywhere on the Moon could have survived such a long series of sudden and devastating disturbances.

It is known that comets are at least as frequent at a distance of 1 A.U. from the Sun as are meteorites or asteroids of comparable masses. The wide distribution of cometary orbital elements is bound to render their high-velocity collisions (in the range 30-70 km./sec.) with the Moon much more frequent than would be the case with the asteroids. Moreover, cometary heads made up of loose conglomerates of mainly frozen hydrocarbons with an appreciable mixture of unstable chemical compounds will on impact behave like high explosives—thus releasing chemical energy in addition to the kinetic energy of the head as a whole. Not being solid, the impact of cometary heads would not penetrate too far into the crust of the Moon and produce destructive seismic waves. The heat produced by the impact explosion will be sufficient to melt the local lunar matter into fluid lava, thus explaining the origin of lunar maria.

It may be suggested that the gas discharge observed by Kozyrev may be an accidental release of some gas deposited there by cometary impact at a distant time in the past.

# CONFOUNDING IN ASYMMETRICAL FACTORIAL DESIGNS IN RELATION TO FINITE GEOMETRIES

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THE problem of confounding in the general symmetrical factorial design  $s^m$ , where  $s$  is a prime positive integer or a power of a prime and  $m$  any positive integer, was solved by Bose and Kishen<sup>1</sup> by representing each treatment combination by a finite point of the associated  $m$ -dimensional projective geometry PG ( $m, s$ ) constructed from the Galois field GF ( $s$ ) and using linear spaces or flats represented by linear equations in  $m$  variables. This method is not applicable to the problem of confounding in the general asymmetrical factorial design  $s_1 \times s_2 \times \dots \times s_m$ , where  $s_1, s_2, \dots, s_m$  are not all equal. A new method of tackling this problem has, therefore, been developed by using curvilinear spaces or hypersurfaces and truncating the EG ( $m, s$ ) suitably, and is briefly described in this note.

2. It is well known that all non-zero elements of GF ( $s$ ) satisfy the equation

$$x^{s-1} = 1 \pmod{\theta(x)}, \quad (1)$$

where  $\theta(x)$  is a minimum function for GF ( $s$ ), of which the elements are denoted as usual by  $\alpha_0, \alpha_1, \alpha_2, \dots, \alpha_{s-1}$ . This suggests that for reducing the levels of any factor in an  $s^m$  design from  $s$  to 2, we have to take the corresponding variable raised to its  $(s-1)$ -th power. Consider, now, the asymmetrical factorial design  $s^{m-1} \times 2$ , in which each of the first  $m-1$  factors is at  $s$  levels and the  $m$ -th factor is at 2 levels. Here we truncate all the points,  $(s-2) s^{m-1}$  in number, lying on the  $s-2$  parallel  $(m-1)$ -flats given by

$$x_m = \alpha_r, \quad (r = 2, 3, \dots, s-1) \quad (2)$$

We are then left with  $s^{m-1} \times 2$  points in the EG ( $m, s$ ) thus truncated, which exactly correspond to the  $s^{m-1} \times 2$  treatment combinations of the asymmetrical factorial design  $s^{m-1} \times 2$ . Consider, now, the pencil of hypersurfaces of  $(s-1)$ -th order represented by the equations

$$x_1 + \alpha_{j_1} x_2 + \dots + \alpha_{j_{m-1}} x_{m-1} + \alpha_{j_m} x_m^{s-1} = d_r \\ (j_2, \dots, j_{m-1} \text{ fixed}; r = 0, 1, \dots, s-1) \quad (3)$$

On each member of this pencil of hypersurfaces lie  $s^{m-2} \times 2$  points, to which correspond  $s^{m-2} \times 2$  treatment combinations of the asymmetrical design  $s^{m-1} \times 2$ . The  $s^{m-2} \times 2$  treatment combinations corresponding to the  $s^{m-2} \times 2$  points lying on a hypersurface may be called the set of treatment combinations corresponding to that hypersurface. The pencil of  $s$  hypersurfaces, therefore, divides the totality of  $s^{m-1} \times 2$  treatment combinations into  $s$  sets of  $s^{m-2} \times 2$  treatment combinations each, which, when assigned to  $s$  blocks, provide one replication of the asymmetrical design  $s^{m-1} \times 2$  divided into  $s$  blocks of  $s^{m-2} \times 2$  plots each, partially confounding  $s-1$  degrees of freedom for the  $(m-2)$ -th order interaction  $A_1 A_2 \dots A_{m-1}$  represented by the pencil

$$x_1 + \alpha_{j_1} x_2 + \dots + \alpha_{j_{m-1}} x_{m-1} = \alpha_r \\ (j_2, \dots, j_{m-1} \text{ fixed}; r = 0, 1, \dots, s-1) \quad (4)$$

and also partially confounding the corresponding  $s-1$  degrees of freedom belonging to the  $(m-1)$ -th order interaction  $A_1 A_2 \dots A_{m-1}$ .

Keeping  $j_2, \dots, j_{m-1}$  fixed in (3) and varying  $j_m$  from 1 to  $s-1$ , we get  $s-1$  pencils of  $s$  hypersurfaces each, which provide all the  $s-1$  replications for a balanced asymmetrical confounded design for  $s^{m-1} \times 2$  treatment combinations in  $s$  blocks of  $s^{m-2} \times 2$  plots each. In case balance on other contrasts of  $s-1$  degrees of freedom each belonging to the  $(m-2)$ -th order interaction  $A_1 A_2 \dots A_{m-1}$  is required,  $s-1$  replications corresponding to each such contrast will also have to be included, so that for achieving complete balance on all the  $(s-1)^{m-2}$  contrasts, each carrying  $s-1$  degrees of freedom belonging to the  $(m-2)$ -th order interaction  $A_1 A_2 \dots A_{m-1}$ ,  $(s-1)^{m-1}$  replications would be necessary.

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3. Consider for example, the  $3 \times 3 \times 2$  design in 3 blocks of 6 plots each, obtained by taking  $m=3$ ,  $s=3$ . Denote the three factors by A (0, 1, 2), B (0, 1, 2), C (0, 1). In EG (3, 3), we truncate the 9 points lying on the plane  $x_3=2$ . This leaves 18 points in this geometry corresponding to the 18 treatment combinations in the  $3 \times 3 \times 2$  design. Here the two replications for the balanced design confounding 2 degrees of freedom for AB and 2 degrees of freedom for ABC are represented by the pencil of surfaces

$$\left. \begin{aligned} x_1 + x_2 + x_3^2 &= 0, 1, 2 \\ x_1 + x_2 + 2x_3^2 &= 0, 1, 2 \end{aligned} \right\} \quad (5)$$

This is the balanced design given by Yates<sup>2</sup> in which AB (J) and ABC (J) are partially confounded.

For achieving complete balance on AB, we have to take two more replications represented by the two pencils of surfaces

$$\left. \begin{aligned} x_1 + 2x_2 + x_3^2 &= 0, 1, 2 \\ x_1 + 2x_2 + 2x_3^2 &= 0, 1, 2 \end{aligned} \right\}, \quad (6)$$

which by themselves give a balanced design partially confounding AB (I) and ABC (I).

Similarly, when we take  $m=3$ ,  $s=5$  in (3), we obtain the balanced confounded  $5 \times 5 \times 2$  design in 5 blocks of 10 plots each. For achieving balance on any contrast carrying 4 degrees of freedom for the first order interaction between the first two factors and the corresponding 4 degrees of freedom for the second order interaction, we require 4 replications, and for achieving complete balance, we require 16 replications. Other balanced asymmetrical confounded designs are readily derivable by this method by giving particular values to  $m$  and  $s$ .

4. Balanced asymmetrical confounded designs of the type  $s^{m_1} \times 2^{m_2}$ , where  $m_1 + m_2 = m$ , in  $s$  blocks of  $s^{m_1-1} \times 2^{m_2}$  plots each, can be constructed by generalization of the method given in Section 2. From EG ( $m$ ,  $s$ ), we truncate all the points lying on the  $(m-1)$ -flats represented by

$$\left. \begin{aligned} x_{m_1+1} &= a, (r=2, 3, \dots, s-1) \\ x_{m_1+2} &= a, (r=2, 3, \dots, s-1) \\ &\dots\dots\dots \\ x_m &= a, (r=2, 3, \dots, s-1) \end{aligned} \right\} \quad (7)$$

This leaves  $s^{m_1} \times 2^{m_2}$  points to which correspond one-to-one the  $s^{m_1} \times 2^{m_2}$  treatment combinations of the asymmetrical design. A

design achieving balance on the contrast carrying  $s-1$  degrees of freedom for the  $(m_1-1)$ -th order interaction  $A_1, A_2, \dots, A_{m_1}$  and the corresponding contrast carrying  $s-1$  degree of freedom belonging to the interaction of the first  $m_1$  factors with the remaining  $m_2$  factors, is then given by the  $(s-1)$  pencils of hyper-surfaces

$$\begin{aligned} x_1 + a_{j_2}x_2 + \dots + a_{j_\lambda} (a_{j_{m_1}}x_{m_1} + a_{j_{m_1+1}}x_{m_1+1}^{s-1} \\ + \dots + a_{j_m}x_m^{s-1}) = a_r \quad (j_2, \dots, j_m \text{ fixed}; \\ \lambda = 1, 2, \dots, s-1; \\ r = 0, 1, \dots, s-1) \end{aligned} \quad (8)$$

Balance is, therefore, achieved in  $(s-1)$  replications.

5. Different types of balanced asymmetrical confounded designs can be derived from an  $s^m$  design by raising the elements of GF ( $s$ ) to different powers and by also forming their linear combinations  $a_0 + a_1x + a_2x^2 + \dots + a_{s-1}x^{s-1}$ ,  $a_0, a_1, \dots, a_{s-1}$  belonging to GF ( $s$ ). Thus when  $s$  is a prime number  $p$  ( $p > 2$ ),

$$(p-k)^2 \equiv k^2 \pmod{p} \quad (9)$$

Consequently, by squaring the  $p-1$  non-zero elements of GF ( $p$ ), we get only  $p-1$  distinct elements corresponding to the squares of the first  $p-1$  non-zero elements 1, 2, ...,  $(p-1)/2$  of GF ( $p$ ). This suggests that for reducing the levels of one or more factors from  $p$  to  $(p+1)/2$ , we have to take pencils of surface with each of the corresponding variables squared up. From a  $p^m$  design, therefore, and the corresponding geometry EG ( $m$ ,  $p$ ), we can derive balanced confounded designs of the type  $p^{m_1} \times \left(\frac{p+1}{2}\right)^{m_2}$  in  $p$  blocks of  $p^{m_1-1} \times (p+1)^{m_2}/2$  plots each, balance on any contrast carrying  $p-1$  degrees of freedom belonging to the interaction of the first  $m_1$  factors, besides its corresponding interaction with the other  $m_2$  factors, being achieved in  $(p-1)$  replications. Balanced confounded designs of the type  $p^{l_1} \times \left(\frac{p+1}{2}\right)^{l_2} \times 2^{l_3}$ , where  $l_1 + l_2 + l_3 = m$ , can be derived by a similar procedure.

6. By a generalization of the results given above, we can obtain balanced confounded designs of the type  $s^{g_0} \times s_1^{g_1} \times s_2^{g_2} \times \dots \times s_t^{g_t}$  (where  $g_0 > 1$  and  $g_0 + g_1 + \dots + g_t = m$ ) in  $s$  blocks of  $s^{g_0-1} \times s_1^{g_1} \times s_2^{g_2} \times \dots \times s_t^{g_t}$  plots each.

By a further generalization of this method, balanced confounded designs of the type  $s^{m_1} \times s_1^{l_1} \times s_2^{l_2} \times \dots \times s_p^{l_p}$  in  $s^k$  blocks of  $s^{m_1-k} \times s_1^{l_1} \times s_2^{l_2} \times \dots \times s_p^{l_p}$  plots each ( $k \leq m_1$ ;  $m_1 + l_1 + l_2 + \dots + l_p = m$ ) can be constructed.

7. The method of truncated finite geometries, with pencils of hypersurfaces to represent replications, developed in this note is a valuable tool in the construction of balanced asymmetrical confounded designs of the type considered and opens up a wide class of problems connected

with the construction and analysis of these designs. Full details of the results obtained will be reported in a separate communication.

1. Bose, R. C. and Kishen, K., "On the problem of confounding in the general symmetrical factorial Design," *Sankhya*, 1940, 5, 21-36.
2. Yates, F., *The Design and Analysis of Factorial Experiments*, Imperial Bureau of Soil Science, Technical Communication No. 35, 1937.

### U.S. MOON ROCKET PIONEER IV

ON March 3, 1959, U.S. launched the four-stage Juno II rocket from the Cape Canaveral missile test centre (Florida). It carried as its nose-cone the 13.4 pound, gold plated space probe, Pioneer IV, designed to pass close to the moon and hurtle millions of miles beyond to become an artificial planet orbiting the sun. Like the Soviet "Lunik" launched just two months earlier on January 2, 1959 (see *Curr. Sci.*, 1959, 28, 47). Pioneer IV had exceeded the second cosmic speed and become the second man-made planet to go round the sun, along a nearly similar orbit. It carried a small transmitter and scientific instruments to measure the extent of radiation in outer space. The giant radio-telescope at Jodrell Bank, Manchester, had tracked Pioneer IV on three successive mornings since its launching and the data received till the time contact was lost with it had been recorded on 12 miles of tape.

Within 4 minutes of the launching, radio-signals from the rocket were picked up by the radio tracking station on Long Island, New York. At 16.00 hrs. GMT the probe was 84,800 miles away from the earth. At 08.45 hrs. GMT on March 4, the Jodrell Bank Observatory reported that Pioneer IV was more than 180,000 miles away from the earth and that signals were still being received quite clearly and that its position could be calculated. At 22.24 hrs. GMT on March 4, Pioneer IV by-passed the moon at a distance of 37,771 miles from it which was more than 17,000 miles further away than had originally been planned.

A pair of photoelectric cells were installed in Pioneer IV which, in addition to their own experimental function, could be triggered by the moon's light. Although they could operate within 20,000 miles of the moon, they could not function at 35,000 miles from it and hence the plans for the probe to announce its own arrival in the moon's vicinity could not be fulfilled.

At 05.36 hrs. GMT on March 5, when Jodrell Bank contacted it again, Pioneer IV was more than 280,000 miles away, already "bang on orbit" as a planet. Data received on telemeter were "not of high class" but "a bit jumpy and not as sound as they should be".

On March 6, at 13.00 hrs. GMT Jodrell Bank lost contact with Pioneer IV when it was more than 405,000 miles away.

The Goldstone tracking station in California lost contact with it at about 15.24 hrs. GMT on March 6. The last signals came from a point deeper in space than any transmission previously recorded.

Pioneer IV's last known position was given as 406,020 miles from the earth when it was travelling at 3899 miles per hour. The batteries of the transmitter were assumed to have run out a few hours after Jodrell Bank lost contact with Pioneer at 13.00 hrs. GMT on March 6. Prof. A. C. B. Lovell, Director of the Observatory said that if the rocket's batteries had had a longer life, the telescope would easily have tracked it to 4 million miles.

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## HISTORY OF MATHEMATICS\*

THE enterprise of the Dover Publications in republishing the well-known work of David Eugene Smith in an unaltered and unabridged form is heartily to be commended. The work appears in two volumes. They are pleasant to handle, easy to read and are modestly priced. The preface states that the work was written for supplying teachers and students with usable text-books on the history of elementary mathematics. Actually, it is a work of very general interest since it deals with one of the fundamental aspects of the development of human thought. Indeed, the work can be justly regarded as a worthy contribution to the history of the cultural progress of mankind.

The first volume considers the history of mathematics chronologically. In ten chapters, the whole field is covered, beginning with prehistoric mathematics followed by the contributions of the ancient civilisations of China, India, Babylon, Egypt and then the work of the early and the later Greeks down to 500 A.D. In the next three chapters the contributions of the eastern world in the medieval period are reviewed alongside those of Europe. In the later chapters, the European countries naturally take the pride of place.

\* *History of Mathematics*. By David Eugene Smith. (Dover Publications, Inc., 920, Broadway, New York), 1958. Price of the complete set (Volumes I & II): \$5.00.

Volume I. General Survey: 167 Illustrations; bibliography; 21 page Chronological Table; Index. Pp. xxii+596. Price: \$2.75.

Volume II. Topical Survey: 329 Illustrations; Index. Pp. xii+725. Price: \$2.75.

The second volume considers the development of mathematics in terms of specific fields and problems. We shall here simply reproduce the chapter-headings: Development of the Arithmetica, Logistic of Natural Numbers, Mechanical Aids to Calculation, Artificial Numbers, Geometry, Algebra, Elementary Problems, Trigonometry, Measures, and finally, the Calculus.

The subject has been handled by the author in such manner that the reader's interest is sustained throughout. The illustrations of the book are well chosen and indeed fascinating. Side by side with the portraits of the great mathematicians of the past, we have specimens of their handwriting, illustrations from the title page of their books, pictures of their instruments, models, maps and sketches of various kinds. The author has brought to bear on his work a remarkable breadth of vision combined with scholarly erudition. No country which has contributed to the growth of mathematics is ignored. No mathematician of any note is forgotten. The author also does not omit to take note of developments in fields closely related to mathematics, e.g., astronomy and physics.

In short, one may say that the perusal of the book is an enjoyable experience. It should find a place in the library of every institution which teaches mathematics and of every individual who is interested in the story of its development.

C. V. R.

## BIOLOGICAL EFFECTS OF ATOMIC RADIATION\*

MAN is exposed to differing intensities of radiation from natural sources like cosmic rays and the radio-active elements present in rocks and soils in the different parts of the world. About 1,00,000 individuals in our own country are living in the monazitic sandy areas of Kerala which show exceptionally high radiation intensities owing to their high content of thorium. The buildings in such areas offer little shielding effect because they are constructed of materials available locally. Often,

the dose received is greater inside the buildings. The radiation from natural sources is negligible when compared to those from man-made sources. Yet, they have a cumulative effect and are suspected to be the agencies responsible for spontaneous mutations in the germ track: those small heritable changes, often deleterious in effect, finding expression in the future generations.

The risks inherent in the diagnostic and therapeutic application of X-rays pale into insignificance when compared to those of use and tests of atomic weapons. The atomic bombs dropped on Hiroshima and Nagasaki killed thousands of people. The survivors did not escape

\* Report of the United Nations Scientific Committee on the "Effects of Atomic Radiation". General Assembly. Official Records: Thirteenth Session, Supplement No. 17, (A/3638), New York, 1958.

unscathed because of the latent effects of exposure to high radiation. The Marshall Islanders and the crew of a Japanese fishing vessel were accidentally exposed to high radiation from the fall-out after a nuclear explosion test.

What is more important is the general contamination of the atmosphere with radio-active materials from the stratospheric fall-out. Some of these like strontium-90 and caesium-137 are potentially hazardous because of their fairly long physical half life, their efficient transfer through food, high absorption by the body and the long retention in the system. Serious consideration has been given to strontium-90 in this context because of its selective incorporation in the bone structure and thus the localized irradiation of osteocyte and marrow cells.

The environmental contamination affects whole populations and the effects may be reflected not only in the present but in future generations also. The report of the Scientific Committee of the United Nations is an objective and exhaustive appraisal of these problems.

The most serious limitation in estimating the hazards to human beings appears to be the absence of any accurate information on the basic mechanisms producing the damage. "While the physical events are more or less understood on the basis of our knowledge of modern physics or physical chemistry, the unknowns on the biological side are still enormous. The need for fundamental research is therefore very great. The only way of meeting this challenge is by the training of scientists in the different disciplines that biological research demands" (p. 21).

There is a wide variation in the radio-sensitivity of different species of animals. Even the various tissues of an organism vary widely in this regard owing to regeneration phenomena and neuro-humoral regulations. The application of the conclusions drawn from animal experiments to Man, can therefore be only speculative in character.

When the whole body has been exposed to a lethal dose as a result of the explosion of a bomb or an accident in the laboratory, death supervenes in 50% of the people within sixty days. An hour or two after exposure there is nausea, vomiting and sometimes diarrhoea. These subside but during the subsequent period of subjective well-being, the blood cells decrease

to very low levels causing progressive anaemia with a tendency to bleeding.

The radiation syndrome is fully developed by the second or third week. There is high fever, loss of weight, extreme exhaustion, loss of hair, ulceration of the mouth and the alimentary tract and hæmorrhages in the skin. The affected individuals become susceptible to infections from the normally harmless bacteria present in the body and usually die as a consequence.

If they survive, the recovery is rather slow because radiation not only damages tissues but also inhibits the process of repair and regeneration. With lower and lower doses, the symptoms become less and less acute and can often be detected with difficulty only from the blood picture. Recovery after a median lethal dose does not ensure later well-being. Delayed effects like leukemia, leucopenia, cataracts, loss of hair, change in texture and pigmentation of the skin and impaired formation of germ cells become apparent after a latent period extending to several years.

Repeated exposure to small doses of radiation during experiments, medical or diagnostic procedures, or from the general environment may have a cumulative effect in producing tumours since the question whether a minimum or threshold dose is necessary for tumour induction remains still unsettled. The difficulty in evaluation is a consequence of the long induction period, which is ten to twenty years for some types of cancer and five to ten years for leukemia, after a single irradiation.

What is more important is that environmental contamination and the consequent continuous exposure of the population to small doses of radio-activity may be reflected in the increased number of mutations determining hereditary disorders, general fertility, intelligence and even the life span of the individual in the succeeding generations.

"While some hazards are implicit in almost all technological advances, it must be remembered that inherited changes are an inescapable consequence of the irradiation of human populations, and that they affect at random persons who can seldom, if ever, be individually identified. They therefore pose ethical and legal problems which should be of special concern to Governments" (p. 30).

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## NATIONAL METALLURGICAL LABORATORY, JAMSHEDPUR: SYMPOSIUM ON "IRON AND STEEL INDUSTRY IN INDIA"

THE symposium organised by the N.M.L. was held from 4th to 7th February 1959 (see *Curr. Sci.*, 1958, 27, 466). The object of the symposium was to focus attention on the latest technological and research developments in the iron and steel industry and their rational utilisations. 37 papers, of which no less than 22 were contributions from outside India, covering the various aspects of iron and steel technology were presented and discussed.

The symposium drew a large gathering of top ranking scientists in different branches of iron and steel from all over the world. Among those who actively participated in it were Prof. Charles Crussard (France), Dr. P. Coheur (Belgium), Dr. T. P. Colclough, Mr. R. H. Colcutt and Mr. W. S. Hindson (U.K.), Prof. G. R. Bashforth (UNESCO), Prof. Erich E. Hofmann and Dr. Carl Popp (Germany), Dr. S. Maekawa and Prof. M. Y. Imai (Japan), and Mr. A. A. Parish (Australia).

The symposium was inaugurated by Prof. M. S. Thacker, Director-General, Scientific and Industrial Research and presided over by Sir J. J. Ghandy, Director-in-charge, Tata Industries Ltd. Dr. B. R. Nijhawan, Director, N.M.L. welcomed the delegates.

The high-light of the programme was the inauguration of the Low-Shaft Furnance Pilot-plant on the 5th February by Hon'ble Sardar Swaran Singh, Union Minister for Steel, Mines and Fuel. In his inaugural address the Hon'ble Minister stressed on the importance of the plant for investigations on pilot-plant scale the production of pig-iron, utilising Indian iron ores and non-metallurgical fuels abundantly available in India. He congratulated Dr. Nijhawan and the research workers for the valuable work that is being done in the N.M.L.

The Low-Shaft Furnance Pilot-plant and auxiliaries were supplied by the Demag-Humboldt Niederschachtofen, Duisburg, West Germany. The Plant has a production capacity of 15 tons of pig-iron per day and will be able to treat different inferior grades of raw materials. The results of investigations to be conducted in this pilot-plant project will help in the establishment of small units for iron and steel production in different parts of the country.

The National Metallurgical Laboratory has issued the first number of its Quarterly Technical Journal which will be its official organ. This inaugural issue has been exclusively devoted for the symposium and contains nine full papers presented besides the abstracts of all the papers.

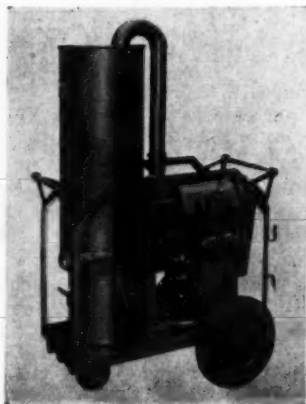
### A NEW INDUSTRIAL VACUUM CLEANER

BIVAC AIR COMPANY, LIMITED of Stockport, England, who have specialized for the past 21 years in the production of industrial vacuum cleaning equipment have recently

announced the introduction of a new, vastly superior, industrial cleaner utilizing the well-proved 'Clear-Flo' air filter design which is non-clogging in operation and requires no shaker gear. This new model is known as the 'CL' and, in the standard version, is powered by a 5 H.P. electric motor. Other motor sizes, or a petrol engine, can readily be fitted if required.

An entirely new exhaustor has been developed for this machine which, though more compact than its predecessors, has greater suction power and is consequently even more efficient.

The 'CL' cleaner has been specifically designed for continuous heavy duty operation where serious vacuum cleaning must be carried out. Wherever large quantities of dust accumulate, or toxic powders have to be handled, the Bivac 'Clear-Flo' filter incorporated in the cleaner is a vital requirement. It prevents these harmful substances from recirculating in an airborne state through the workrooms.



## UNDERGROUND WATERS ARE SOURCE OF HEAT ENERGY

F. A. MAKARENKO

**U**NDERGROUND waters are a cheap source of heat. The waters at such depths of the Earth's crust, that are quite accessible for present-day boring techniques, get considerably heated and form major artesian basins and fissure systems with great reserves that are continuously replenished by natural means. This kind of heat energy of the Earth's entrails is practically inexhaustible: many natural thermal springs function uninterruptedly throughout a geological period.

Heat from underground waters has been used by man since the most ancient times. Excavations of Neolithic, and probably of Paleolithic, man have been found near now-functioning thermæ. Ancient baths, cave settlements, remains of the culture of the bronze and early iron age have been found in the area of Mineral Waters in the Caucasus and in Armenia.

However, there were quite few natural outlets of thermal springs and very rarely were they situated in places that were convenient for settlements. Most frequently they were used for medicinal purposes. It is only with the development of scientific knowledge of underground and thermal waters, with the introduction of deep-hole boring, mainly in the last two decades, that the problem of large-scale economic utilization of the heat of underground waters started to attract universal attention.

Thermal underground waters which even recently were considered to be "specific" and "rare", beginning at certain depths and increasing in temperature as they become deeper, may be considered as continuous zones of underground waters. On the other hand, underground "cold" waters which are considered to be the usual thing are characteristic of a comparatively small top zone that forms only a thin covering film, if compared with the many-kilometre-deep layer of hot and superheated waters of the entrails of the Earth!

Being under pressure and having thermal capacity higher than the surrounding rock, the underground water accumulates heat generated underground and by force of its own dynamic energy conveys it in great quantities up to the surface. The excess pressure of drilling waters, which attains tens of atmospheres, ensures the

transfer of heat to the sites of consumption on the surface and creates considerable hydraulic energy.

In recent years thermal springs are finding ever greater application for heating and power production purposes. High temperature underground waters and vapours are utilized for producing electric energy, for central heating of towns, for warm water-supply, in agriculture for heating hotframes and hothouses, in public baths, bathing pools, and in shower installations. They have also found extensive application for medicinal purposes. These, however, are but the first steps in their versatile application.

In the Soviet Union underground water heat is mostly employed at the site, at the thermal spring outlets—in the various spas (Kuldur, Goryachevodsk, Braguny, Chukotka territory, Kamchatka, Magadan region, the Kuril Islands, Hoji-Obigarm, Transcaucasia) and in many oil-field districts.

Lately the work conducted by Soviet geologists, hydrogeologists, and geophysicists, has resulted in vast basins of bedded and fissure waters being found in the Caucasus, Transcaucasia, Central Asia, in the European part of the USSR, in various areas of Siberia and in Kamchatka. It is reported that there are hot bedded and fissure waters in the permafrost areas in the North and North-East of the Soviet Union under the strata of frozen rock: major thermal springs break through the layer of frozen rock there and appear at the surface with a temperature of up to 90-100° C. and with an immense yield (Chukotka territory, Okhotsk Sea coast, some areas of the Northern Urals etc.). Many hot artesian water basins cover territories of tens and hundreds of hectares, while some of them, as for example the West Siberian artesian thermal water basin, cover a territory of millions of square kilometers.

The exceptional abundance of thermal waters in the USSR has been convincingly shown in a number of papers read at the first USSR Geothermal Conference held in 1956.

In the Caucasus which is better investigated in geothermal respect than other territories of the USSR a number of foothill and inter-hill underground water basins have been discovered that possess great pressures, valuable chemical

composition, and considerable water yields in the boreholes, the water temperature in the geosyncline flexures of many aquifers being 100-150° C. and up to 270° C. and over. Their resources are practically unlimited. Many hot waters possess an excess pressure of tens of atmospheres under the hole mouth, contain valuable salts and rare elements (iodine, bromine, boron, sulphur, etc.) in industrial quantities. The boreholes usually have quite a large yield—up to 50 litres per second and sometimes even as high as 100 litres per second and over.

Not so long ago the existence of hot waters on the territory of the European part of the USSR had not even been suspected. But this area turned out to be a territory of thermal and high-thermal water development at considerable depths—1,500 m and deeper (Second Baku District, Dnepropetrovsk—Donets syncline, North Caspian area, Moscow syncline, and others).

At a number of extremely large artesian basins in Turkmenia (Kopet-Dag flexure, West Turkmenia's basins, etc.), in the Uzbek SSR (Tashkent, North-Tashkent, Ferghana basins, etc.), in the Tajik SSR, in the foothills of the Tyan-Shan mountains within the boundaries of Kirghiz SSR the deep underground waters with zonal variations of mineralization and chemical composition are characterized by still higher temperatures.

Thermal springs are no less developed in the central and eastern parts of Siberia, within the Chukotka territory, and in the areas of the Pacific coasts of the USSR. There are hundreds of natural outlets in the Transbaikal region alone, characterized by very high temperatures and great yields, making it possible to provide a multitude of towns and villages with central heating and to set up local health resorts, as well as, major hothouse and hotframe vegetable establishments.

Well-known are the countless thermal springs, geysers, and hot vapour and gas fumaroles in the present-day volcanic areas of the Kamchatka and Kurile volcanic islands arc. The heat from the depths of these areas may

be used for creating major geothermal power plants, while many of the natural thermal springs on Kamchatka and the Kurile islands may serve as bases for large-scale hothouse vegetable and fruit growing establishments that are so important for the population of the Far East.

Thus, the hydrothermal resources of the Soviet Union are practically boundless. They may be brought on to the surface by boring to greater or smaller depths in many regions of the country.

The Laboratory of Hydrogeological Problems of the USSR Academy of Sciences together with other institutions has recently compiled the first general summary of the prospected sources of underground water and vapour heat in the USSR, to be utilized for heating and power production purposes. This summary recommends that over 60 towns be supplied with central heating and suggests more than 100 districts where hot underground waters should be regionally used for agriculture, residential house heating, communal, technical, and sanitary-hygienic purposes.

Preliminary calculations show that for organizing the central heating of a town with 100 thousand inhabitants it is sufficient to utilize two or three high-yield holes with hot water, which, according to the data furnished by the Daghestan Branch of the USSR Academy of Sciences, will give a saving of no less than 10 million rubles.

The utilisation of the heat of underground waters for commercial purposes will not only provide a great saving but this energy of the Earth will save the national economy millions of tons of wood fuel, coal, and oil and will considerably relieve pressure on transport.

Many medicinal and oil-bearing thermal springs in the Caucasus bring to the surface great quantities of sulphur, boracic acid, bromine, iodine, carbon dioxide, helium, lithium, and other elements. The yield in drilled and natural thermal springs of some scarce salts and elements comes to tens, hundreds, and even thousands of tons a year.

## LETTERS TO THE EDITOR

A SHORT NOTE ON  
SELF-RECIPROCAL FUNCTIONS

1. FOLLOWING the notation of Hardy and Titchmarsh,<sup>3</sup> we denote a function  $f(x)$  as  $R_\mu$ , if it is Self-Reciprocal for Hankel Transforms of order  $\mu$ , so that it is given by

$$f(x) = \int_0^\infty J_\mu(xy) f(y) \sqrt{xy} dy, \quad (1.1)$$

where  $J_\mu(x)$  is a Bessel function of order  $\mu$ . If, however,  $f(x)$  is replaced by  $-f(x)$  on the left-hand side of (1.1), then  $f(x)$  is said to be Skew Reciprocal for Hankel Transforms of order  $\mu$  and is denoted by  $-R_\mu$ . In this note we find a Self-Reciprocal function, particular cases of which reduce to functions already obtained.

2. Theorem:

If  $f(x)$  is  $\pm R_\mu$ ,

$$\text{then} \quad \phi(x) = F^n(a) f(xF^{2n}(a)) \pm \frac{1}{F^n(a)} f\left\{\frac{x}{F^{2n}(a)}\right\}, \quad (2.1)$$

is  $\pm R_\mu$ , where  $F(a) \neq 0$ ,

Proof:

$$\begin{aligned} \int_0^\infty J_\mu(xy) \phi(y) \sqrt{xy} dy &= \int_0^\infty J_\mu(xy) \left[ F^n(a) f(yF^{2n}(a)) \pm \frac{1}{F^n(a)} f\left(\frac{y}{F^{2n}(a)}\right) \right] \sqrt{xy} dy, \\ &= \int_0^\infty J_\mu(xy) F^n(a) f(yF^{2n}(a)) \sqrt{xy} dy \\ &\quad \pm \int_0^\infty J_\mu(xy) \frac{1}{F^n(a)} f\left[\frac{y}{F^{2n}(a)}\right] \sqrt{xy} dy. \end{aligned} \quad (2.2)$$

Putting  $yF^{2n}(a) = u$  in the first integral of the right-hand side, we find that it becomes

$$\frac{1}{F^n(a)} \int_0^\infty J_\mu\left[\frac{xu}{F^{2n}(a)}\right] f(u) \sqrt{\frac{xu}{F^{2n}(a)}} du,$$

$$\text{which is} = \frac{1}{F^n(a)} f\left\{\frac{x}{F^{2n}(a)}\right\}$$

since  $f(x)$  is  $R_\mu$ . (2.3)

Similarly putting  $\frac{y}{F^{2n}(a)} = u$  in the second

integral of the same side, we find that it becomes

$$\begin{aligned} F^n(a) \int_0^\infty J_\mu[xuF^{2n}(a)] f(u) \sqrt{xuF^{2n}(a)} du, \\ \text{which is} = F^n(a) f(xF^{2n}(a)). \end{aligned} \quad (2.4)$$

Hence we find that

$$\int_0^\infty J_\mu(xy) \phi(y) \sqrt{xy} dy = \pm \phi(x), \quad (2.5)$$

according as  $f(x)$  is  $\pm R_\mu$  where

$$\phi(y) = F^n(a) f(yF^{2n}(a)) \pm \frac{1}{F^n(a)} f\left\{\frac{y}{F^{2n}(a)}\right\}.$$

Putting  $n=1$ , we find that

$$\phi(y) = F(a) f(yF^2(a)) \pm \frac{1}{F(a)} f\left\{\frac{y}{F^2(a)}\right\}. \quad (2.6)$$

which has been shown to be  $R_\mu$ , by Dr. Brij Mohan.<sup>1</sup>

Again putting  $F^n(a) = a^n$ , we find that the function

$$\phi(y) = a^n f(ya^{2n}) \pm \frac{1}{a^n} f\left(\frac{y}{a^{2n}}\right), \quad (2.7)$$

which is also due to Dr. Brij Mohan.<sup>2</sup>

3. Examples:

The author has shown in previous paper<sup>4</sup> that the function

$$\frac{J_\mu(a_1x) J_\nu(a_2x) \dots J_k(a_nx)}{x^{\mu+\nu+\dots+k}}, \quad (3.1)$$

where  $a_1 + a_2 + \dots + a_n$  is finite and  $a_1, a_2, \dots, a_n$  are all +ve, is  $R_1$ .

Hence from (2.1), it follows that

$$\begin{aligned} &\frac{F^n(a) J_\mu[a_1xF^{2n}(a)] J_\nu[a_2xF^{2n}(a)] \dots J_k[a_nxF^{2n}(a)]}{[F^{2n}(a)x]^{\mu+\nu+\dots+k}} \\ &\pm \frac{1}{F^n(a)} \frac{J_\mu\left[\frac{a_1x}{F^{2n}(a)}\right] J_\nu\left[\frac{a_2x}{F^{2n}(a)}\right] \dots J_k\left[\frac{a_nx}{F^{2n}(a)}\right]}{\left[\frac{x}{F^{2n}(a)}\right]^{\mu+\nu+\dots+k}}, \end{aligned} \quad (3.2)$$

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where  $a_1, a_2, \dots, a_n$  are all +ve and finite, and  $F(a) \neq 0$ , is  $R_{1/2}$ .

Again, as has been shown in another paper<sup>5</sup> that the function

$$\left[ J_1 \left( \frac{x}{\sqrt{2}} \right) \right]^2, \quad (3.3)$$

is  $R_{3/2}$ .

Hence it follows from (2.1), that

$$F^n(a) J_1^2 \left[ \frac{x F^{2n}(a)}{\sqrt{2}} \right] \pm \frac{1}{F^n(a)} J_1^2 \left[ \frac{x}{F^{2n}(a) \sqrt{2}} \right], \quad (3.4)$$

where  $F(a) \neq 0$ , is  $R_{5/2}$ .

My thanks are due to Dr. Brij Mohan for his help and guidance in the preparation of this note.

No. 1-5-106, Mushirabad, V. V. L. N. RAO.  
Hyderabad, (Dn.),  
July 23, 1958.

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# THE ANOMALOUS NUCLEAR SCATTERING OF HIGH ENERGY MUONS

THE multiple nuclear scattering of cosmic radiation muons of energies between 600 Mev and 100 Gev turns out to be anomalously consistent with the nuclear electrostatic scattering by a point nucleus as observed and summarised by Lloyd, Rössle and Wolfendale.<sup>1</sup> Further, the observed scattering varies as  $Z^2$  or  $A^2$  indicating that it is largely elastic. At the same time the observed nuclear star production cross-section is very small as determined by George and Evans.<sup>2</sup>

The purpose of the present investigation is to consider the possible nuclear optical model for such anomalous nuclear scattering of high energy muons. The muon spin is disregarded as its effects cancel out in the proposed comparison. It is reasonable to assume the approximate validity of the first Born approximation for such a preliminary consideration.

Assuming spherical symmetry, the scattering amplitude in this approximation is given by

$$f(s) = -\frac{1}{s} \int_0^\infty U(r) \sin(sr) r dr, \quad (1)$$

where  $s = 2k \sin(\theta/2)$  while  $U(r) = 2EV(r)/$

$(\hbar c)^2$  with  $V(r)$  the complete nuclear potential. One can now write

$$U(r) = -2kn\rho(r) + V_e(r), \quad (2)$$

where  $n = n_1 + in_2$  is the nuclear complex refractive index parameter,  $\rho(r)$  is the nuclear density and  $V_e(r)$  represents the nuclear electrostatic potential.

Assuming a uniform nuclear density distribution of radius  $R$ , one obtains, with  $a = Ze^2/\hbar c$ , the elastic scattering cross-section as

$$\sigma(s) = \frac{9k^2}{s^4} \left[ \left\{ \frac{2a}{(sR)^2} + \frac{n_1 A}{2\pi R^2} \right\}^2 + \left\{ \frac{n_2 A}{2\pi k} \right\}^2 \right] \left[ \frac{\sin(sR)}{(sR)} - \cos(sR) \right]^2. \quad (3)$$

The large fluctuations in  $\sigma(s)$  produced by the last factor of equation (3) will be disregarded in the present approximate consideration, since exact calculations by Yennie *et al.*<sup>3</sup> show that they are considerably smaller than those given by equation (3). As the electrostatic scattering for such an extended nucleus is negligible as compared to the anomalous scattering for large values of  $s$ , one can write for such values of  $s$

$$\sigma(s) \approx \frac{9k^2 A^2 |n|^2}{4\pi^2 (sR)^4}. \quad (4)$$

But for such large  $s$ , the experimental observations agree anomalously with the nuclear electrostatic scattering by a point nucleus, given by

$$\sigma(s) = \frac{4k^2 a^2}{s^4}. \quad (5)$$

Thus one obtains  $|n| = 4\pi a R^2 / 3A$  by comparing equations (4) and (5).

Taking  $R = 1.1 A^{1/3} f$ , one obtains  $|n| \approx 5 mb$  for lead and  $|n| \approx 3 mb$  for iron. Of course  $|n|$  must be the same for each nucleus and may be taken to be about 4 mb on the average. The absorption cross-section  $\sigma_a$  to the first order in refractive index is given by  $\sigma_a = 2n_2 A$  as shown by Gatha and Shah.<sup>4</sup> Substituting the observed values of  $\sigma_a$ , one gets  $n_2 \approx 0.005 mb$  and hence  $n_1 \approx 4 mb$ .

It is now possible to get some information about muon-nucleon interaction from the values of  $n_1$  and  $n_2$ . One has, in the impulse approximation  $n = 2\pi f(o)/k$  where  $f(o) = f_1(o) + if_2(o)$  is the complex forward scattering amplitude for scattering by free nucleons. One can now use the optical theorem giving the total scattering cross-section  $\sigma_t = 4\pi f_2(o)/k$ , which leads to  $\sigma_t = 2n_2 \approx 0.01 mb$ .

One may regard this  $\sigma_t$  to be largely due to inelastic processes like pion production. But as  $n_1 \gg n_2$  one has  $f_1(o) \gg f_2(o)$  which is rather unlikely for such processes. Also such pions have not been observed. On the other

hand an anomalous real potential between muon and nucleon can give the necessary large value for  $f_1(0)$  and small value for  $f_2(0)$  since only  $f_1(0)$  would be given by the first Born approximation while  $f_2(0)$  would be given only by the higher Born approximations. Hence one may regard the muon-nucleon scattering as largely elastic and try to find out the approximate range of such a potential.

For such a real potential the elastic scattering cross-section  $\sigma_e = \sigma_t$  is given by

$$\sigma_e = \frac{2\pi}{k^2} \int_0^{2k} |f(s)|^2 s ds \approx 0.01 \text{ mb.} \quad (6)$$

For a rough estimate of the range of  $s$ ,  $|f(s)|^2$  may be assumed to be a step function given by  $|f(s)|^2 = |f(0)|^2 \approx |f_1(0)|^2$  upto  $s = S$  and  $|f(s)|^2 = 0$  for  $s > S$ . Substituting in equation (6) one obtains  $S \approx 3 \times 10^{12} \text{ cm}^{-1}$ . The range of the corresponding potential, in the first Born approximation may be approximately given by  $1/S \approx 3f$ . The approximate order of magnitude of the mass of the exchanged quantum, giving rise to such an anomalous potential, would then be about a hundred electron masses. Such an exchange interaction between muon and nucleon is therefore expected to give agreement with the observed anomalous nuclear scattering of high energy muons, while it will be negligible in comparison with the electrostatic interaction at lower energies. These investigations are now in progress.

Physics Department,  
Institute of Science,  
Bombay-1, January 15, 1959.

K. M. GATHA.  
V. B. KELKAR.

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## STUDY OF ULTRASONIC VELOCITY IN ORGANIC SOLUTIONS

WHILE investigating ultrasonic velocities in solutions of organic substances like naphthalene, etc., in organic solvents, Schaaffs<sup>1</sup> and others<sup>2</sup> have shown that, in general, the ultrasonic velocity increases linearly with concentration. Subsequently Lal and Sharma<sup>3</sup> have reported a consistent decrease of ultrasonic velocity with increase of concentration for the solution of benzoic acid in several alcohols. It was also shown that the molar sound velocity  $R$  of the solution increases linearly with molar fraction and that the extrapolated value for 100% concentration is a characteristic constant for the pure solid. In a recent communication Lal<sup>4</sup> has utilised Rao's equation to calculate the ultrasonic velocity in the pure solid solute existing in a hypothetical liquid state and the value thus obtained for benzoic acid was reported as 3,920 m./sec.

The authors have systematically investigated the ultrasonic velocities in solutions of benzoic acid in chloroform, benzene and ethyl alcohol using the variable frequency fixed path interferometer<sup>5</sup> and the results are presented in Table I.

It will be seen from the results presented in Table I that the velocity increases with concentration for all the solvents studied in a more or less linear manner, a result which is contrary to the conclusions of Lal and Sharma.<sup>3</sup> But as reported by them, the values of  $R$  are found to increase linearly with molar fraction, but the average of the extrapolated values for 100% concentration obtained by us is 1174 as against the average value of 1527 reported by them. It is to be noted that the present value of  $R$  compares favourably with the calculated value of 1213 obtained by Rao's method of atomic increments and the value of 1199 obtained by Lagemann method of bond increments.

TABLE I  
Room Temperature 30°C.

| Benzoic acid chloroform    | Cm. % | 0       | 2.595 | 5.051 | 7.431 | 9.618 | 100 (extrapolated) |
|----------------------------|-------|---------|-------|-------|-------|-------|--------------------|
|                            |       | V m./s. | 985   | 991   | 998   | 1012  | 1027               |
|                            | R     | 807.6   | 816.0 | 823.5 | 831.6 | 841.0 | 1181               |
| Benzoic acid Benzene       | Cm. % | 0       | 2.788 | 4.660 | 6.829 | ..    | 100 (extrapolated) |
|                            |       | V m./s. | 1264  | 1297  | 1304  | 1312  | 1622               |
|                            | R     | 975.2   | 978.8 | 984.5 | 991.7 | ..    | 1216               |
| Benzoic acid-ethyl alcohol | Cm. % | 0       | 1.540 | 3.031 | 4.479 | ..    | 100 (extrapolated) |
|                            |       | V m./s. | 1140  | 1151  | 1163  | 1168  | 1718               |
|                            | R     | 587.3   | 606.1 | 614.6 | 622.6 | ..    | 1154               |

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## SYNTHESIS

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As the variation of ultrasonic velocity with concentration is almost linear, in the limited concentration range possible, the velocity for 100% concentration is obtained by extrapolation and the values thus obtained for the three solvents are fairly consistent. This velocity does not correspond to the velocity of the solute in the solid state but it corresponds to the characteristic velocity for the hypothetical case of the solute existing in the liquid state at the room temperature. This value cannot therefore be checked by a direct determination. However, it is interesting to note that this average value 1657 m./sec. is in reasonable agreement (considering the wide range of extrapolation) with the value of 1506 m./sec. obtained from Rao's formula using the known value of R for the solute and assuming a density<sup>6</sup> value of 1.166 gm./c.c.

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#### SYNTHESIS OF 5'-BENZOYL-3'-CHLORO-2'-HYDROXYCHALKONES

ALTHOUGH a considerable amount of work has appeared describing the synthesis of the chalkones containing hydroxy and alkoxy groups in the phenyl and styryl components, those containing other substituents have been comparatively less studied. Some chalkones containing halo,<sup>1</sup> acetamino,<sup>2</sup> carboxyl<sup>3</sup> and nitro<sup>4</sup> groups have been reported in the literature, and recently the chalkones containing the benzoyl<sup>5</sup> groups have been reported from this laboratory.

In continuation of such work 5-benzoyl-3-chloro-2-hydroxyacetophenone prepared by the Fries migration of 2-chloro-4-benzoylphenyl acetate (under publication) has been condensed with various aldehydes.

All the chalkones gave characteristic deep red colour with concentrated sulphuric acid and brownish red colour with alcoholic ferric chlo-

ride. Most of them were sparingly soluble in sodium hydroxide giving yellow colour.

The chalkones obtained with various aldehydes are listed in Table I.

TABLE I

| Benzaldehyde              | M.P. of the chalkone °C. | Formula of the chalkone | Chlorine percentage required | Found |
|---------------------------|--------------------------|-------------------------|------------------------------|-------|
| 1. Benzaldehyde ..        | 142                      | $C_{22}H_{15}O_3Cl$     | 9.79                         | 9.51  |
| 2. 2-Hydroxy ..           | 199                      | $C_{22}H_{15}O_4Cl$     | 9.38                         | 9.07  |
| 3. 3-Hydroxy ..           | 160                      | $C_{22}H_{15}O_4Cl$     | 9.38                         | 9.11  |
| 4. 4-Hydroxy ..           | 22                       | $C_{22}H_{15}O_4Cl$     | 9.78                         | 9.02  |
| 5. 4-Methoxy ..           | 161                      | $C_{23}H_{17}O_4Cl$     | 9.05                         | 8.87  |
| 6. 3-Methoxy-4-hydroxy .. | 167                      | $C_{23}H_{17}O_5Cl$     | 8.6                          | 8.32  |
| 7. 3,4-Methylene dioxy .. | 195                      | $C_{23}H_{15}O_5Cl$     | 8.73                         | 8.46  |
| 8. 3-Nitro ..             | 155                      | $C_{22}H_{14}O_5NCl$    | 8.71                         | 8.48  |
| 9. 3-Chloro-4-Methoxy ..  | 195                      | $C_{23}H_{16}O_4Cl_2$   | 16.63                        | 16.38 |

Of the above chalkones, 5'-benzoyl-3'-chloro-2'-hydroxychalkone (No. 1) was cyclised to the corresponding flavanone, m.p. 131° (Found: Cl, 9.54,  $C_{22}H_{15}O_3Cl$ , required Cl, 9.79 per cent.) by alcoholic sulphuric acid.<sup>6</sup> It was also oxidised to 6-benzoyl-8-chloroflavone m.p. 197-98°, (Found: Cl, 9.61,  $C_{22}H_{13}O_3Cl$  required Cl, 9.85 per cent.) and 6-benzoyl-8-chloroflavanol m.p. 265° (Found: Cl, 9.14,  $C_{22}H_{13}O_4Cl$  required Cl, 9.43 per cent.) by selenium-dioxide in amyl-alcohol<sup>7</sup> and alkaline hydrogen peroxide<sup>8</sup> respectively.

Further work is in progress.

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# INFRARED AND RAMAN INTENSITIES OF ALIPHATIC DERIVATIVES

BELLAMY<sup>1</sup> and Rao and Silverman<sup>2</sup> first pointed out that the infrared group frequencies in aliphatic compounds can be correlated by the Taft aliphatic polar substituent constants,  $\sigma^*$ , of groups.<sup>3</sup> The infrared band intensities of aliphatic derivatives have also been shown to depend on the polar contributions of groups.<sup>4</sup> We have now tried to correlate the infrared and the Raman intensities of the hydroxy group and the carbonyl group in aliphatic alcohols and ketones respectively.

The infrared band intensities,  $A_m$ , of the hydroxy group in aliphatic alcohols reported by Brown and Rogers<sup>5</sup> and Flett<sup>6</sup> were normalized by a scale factor and plotted against the  $\sigma^*$  constants (cf. Fig. 1). An approximately linear relation with a positive slope is observed. The hydroxy frequencies show a linear relation with  $\sigma^*$  with a negative slope.

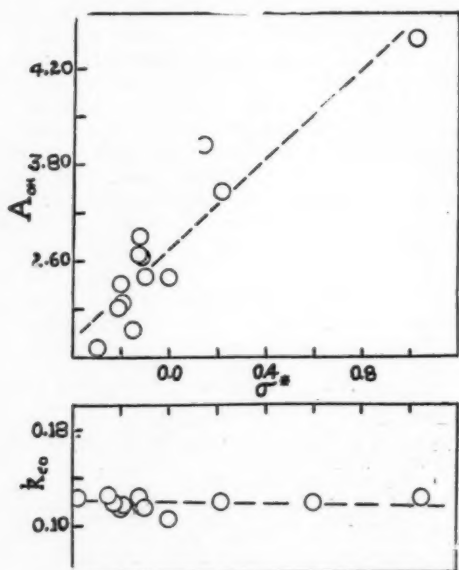


FIG. 1. Plots of the infrared intensities of the aliphatic alcohols and the Raman intensities of aliphatic ketones against the Taft  $\sigma^*$  parameters.

In Fig. 1 the Raman intensities of the carbonyl group in aliphatic ketones<sup>7</sup> are plotted against the  $\sigma^*$  constants. The Raman intensities have been expressed in terms of the scattering coefficients,  $k_c$ . The carbonyl group intensity seems to be rather insensitive to structural

variations. A similar observation has been made earlier with regard to the infrared carbonyl intensities in aromatic derivatives.<sup>8</sup> However, the carbonyl band intensity in aliphatic amides has been found to vary considerably with structural environment<sup>4</sup> and to show a linear relation with  $\sigma^*$  with a negative slope. The carbonyl frequencies in aliphatic ketones give a  $\nu$ - $\sigma^*$  linear plot with a positive slope.<sup>9</sup>

It appears fairly general that the group frequencies and intensities in aliphatic derivatives can be correlated by the Taft  $\sigma^*$  parameters. The slopes of the linear relations of the frequencies and the intensities in both aliphatic and benzene derivatives<sup>8</sup> bear opposite signs.

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## A NOTE ON THE STUDY OF HAEMOGLOBINS BY PAPER ELECTROPHORESIS

SINCE it has been reported by Pauling et al.<sup>1</sup> that sickle cell anaemia is a molecular disease and the electrophoretic mobilities of normal and sickle cell haemoglobins are different, electrophoresis has become more or less a standard procedure for the differentiation of some haemoglobin variants. Though less sensitive than the moving boundary method, filter-paper electrophoresis has subsequently been applied quite widely for this purpose because of the simplicity of the apparatus and the ease of manipulation. Sickle-cell trait among the population in some tribal areas in India has been reported by various workers and the most recent survey pertaining to some tribes in western India is that of Sukumaran et al.<sup>2</sup> An attempt has been made here to examine by this technique the

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haemoglobin of an adult woman patient provisionally diagnosed as a case of sickle cell anaemia; foetal blood haemoglobin and haemoglobin of normal individuals have also been examined simultaneously. Some of the observations are reported below.

The method of haemoglobin preparation and the electrophoresis apparatus used were similar to those described by Smith and Conley.<sup>3</sup> Veronal buffer of pH 8.6 and 0.05 molar strength was used. The voltage applied was 280 and the current passing was of the order of 10 milliamperes. Using comparable concentrations, lying between 2 to 5 per cent., the one from the patient was shown to be slower than the normal variant (Fig. 1). This differ-

globin, and it tended to retard the migration of the latter in an admixture. To render this technique more reliable as a means of identification it would be desirable to place identically treated controls of known composition on the strip containing the unknown sample. Considering the various limitations, as pointed out by others<sup>4-6</sup> as well, it is recognised that this technique as such may be considered as a useful adjunct to other physico-chemical and clinical methods of analysis.

The author is thankful to Dr. D. S. Kothari, Scientific Adviser to the Minister for Defence, for his kind interest in this work, and to Lt.-Col. S. K. Mazumdar, A.M.C., for helping to procure the samples.

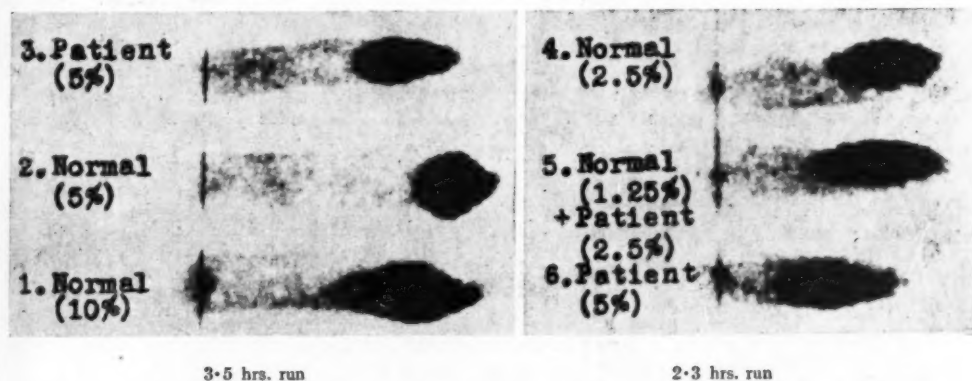


FIG. 1. Relative positions of haemoglobins from a normal subject and the anemic patient using different concentrations and time of run. Figures in parentheses refer to the approximate haemoglobin concentrations in the test solutions.

ence became quite distinct within two hours and a run over four hours was not considered necessary. Too long a run on the other hand, resulted in only diffused pattern with no further fractionation. Thus from the patterns obtained under the present experimental condition it was quite clear that the unknown sample was definitely different from the normal one. While an accurate measurement of electrophoretic mobility was not found feasible by this technique, a comparison of the present picture with that reported in the literature<sup>3</sup> for different haemoglobins and microscopic examination of the red cells suggest the haemoglobin from the patient to be of the sickle cell type. While examining separately the haemoglobin of foetal blood, it was noticed that its relative migration was not much different from that of normal haemo-

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# IDENTIFICATION OF CHOLIN- ESTERASE IN COBRA VENOM AFTER ELECTROPHORETIC SEPARATION ON STARCH GEL

VENOMS of *Colubridae* species are characterized by the presence of cholinesterase while it is absent in venoms of *Viperidae*.<sup>1</sup> Identification of enzymes after electrophoresis is usually carried out by adapting histochemical procedures.<sup>2</sup> Those so far in use for the localization of cholinesterase<sup>3-6</sup> are dependent on the hydrolysis of suitable substrate and converting the products of reaction into dyes by suitable coupling agents. Recently, Kramer and Gamson<sup>7</sup> have introduced indophenyl acetate as a substrate for direct colorimetric estimation of acetyl-cholinesterase activity and have worked out conditions for its quantitative determination. The present communication describes the application of indophenyl acetate as a chromogenic agent to locate the position of cholinesterase in electrophoretic strip or gel.

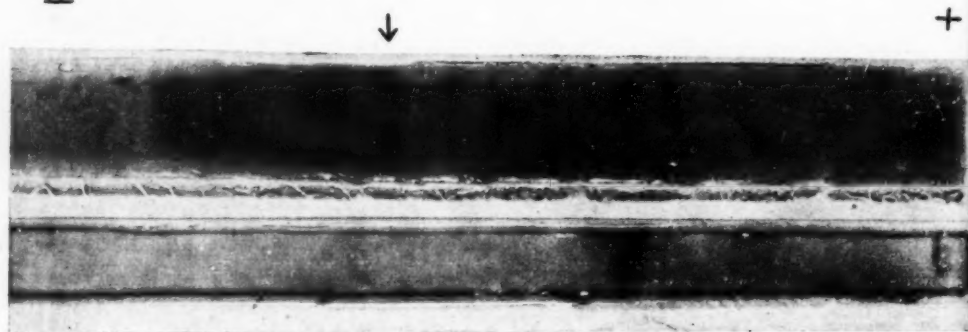


FIG. 1. Electrophoresis of cobra venom in starch gel. Upper strip: Stained for proteins with Amido black 10 B. Lower strip: Treated with indophenyl acetate for cholinesterase.

Electrophoresis of cobra venom was carried out on starch gel according to the method of Smithies<sup>8</sup> using 10% potato starch gel prepared in tris-citrate buffer (pH 8.6, ionic strength 0.05) as recommended by Poulik.<sup>9</sup> The electrode vessels contained borate buffer of same pH and ionic strength. Each of the starch blocks was 2.0 mm. thick, 25 cm. long and 2.5 cm. wide. Four such blocks cast over cellophane paper supported on glass sheet were subjected to electrophoresis for about 5 hours at 12 milliamperes.

After electrophoresis, one starch block was stained for proteins, using 0.5% amido black 10 B in a mixture of acetic acid: methanol:

water in the ratio of 1:5:4, for one minute. The block was then washed repeatedly with 1% acetic acid.

The stained blocks can also be dried at room temperature in a current of air on a glass sheet and in that condition are more or less transparent and can be preserved.

The second starch block was covered with a thin layer of indophenyl acetate solution (0.1 cc. stock solution containing 0.375 g. indophenyl acetate in 25 c.c. ethanol, is diluted to 2.5 cc. with veronal buffer pH 8.0). Within about 5 minutes a dark blue band locating the position of cholinesterase could be seen against an orange background.

Figure 1 shows the starch electrophoresis blocks stained for protein (upper) and for cholinesterase (lower).

Venoms of cobra and krait showed the presence of cholinesterase while the venoms of Russell's viper and saw-scaled viper did not show its presence. The method described above is of

general application for identification of cholinesterase from other sources also.

The authors are grateful to Dr. A. K. Hazra, Assistant Director, and Dr. H. I. Jhala, Director for their encouragement. We express our grateful thanks to Dr. D. N. Kramer, U.S. Army Chemical Warfare Laboratories, for kindly sparing us a little indophenyl acetate for these experiments. One of us (R. W. P. M.) is grateful to the Government of Bombay for the award of a Fellowship.

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# SYNTHESIS OF 1-(4'-VERATRYL)-(N- $\gamma$ -AMINO-N-PROPYL)-ALKYLAMINES

A NUMBER of diamines have been synthesised by various workers<sup>1-2</sup> in order to find a suitable substitute for emetine in amœbiasis but so far none of the compounds synthesised proved superior to emetine *in vivo*. The authors have however attempted the synthesis of 1-(4'-veratryl)-(N- $\gamma$ -amino-n-propyl)-alkylamines with alkyl substitutions as ethyl, n-propyl, n-butyl, n-amyl and n-hexyl with a view to test their amœbicidal activity. Acyl veratroles were reduced to 1-(4'-veratryl)-alkylamines through the reduction by sodium and alcohol of the corresponding oximes. These mono-amines were condensed with acrylonitrile to form the cyanœthyl products which on reduction with lithium aluminium hydride gave 1-(4'-veratryl)-(N- $\gamma$ -amino-n-propyl)-alkylamines. These diamines are being tested for their pharmacological activity. The details of the synthesis will be published elsewhere.

The authors express their sincere thanks to Dr. Mata Prashad, Vice-Chancellor, Vikram University for providing research facilities.

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## RHIZOSPHERE MICROFLORA OF PTERIDOPHYTES

MUCH work has been done on the rhizosphere microfloras of angiosperms.<sup>1-6</sup> Despite the fact that root systems of pteridophytes have been shown to harbour fungal root parasites of cultivated crop plants,<sup>8</sup> as for instance, the isolation of *Corticium koleroga* (Cke) V.H. (which causes

the coffee root disease) from *Polypodium lineare* Thw. and *Cyclophorus* (Niphobolus) *acrostichoides* J. Sm.,<sup>7</sup> and the isolation of plurivorous parasites like *Sclerotium rolfsii* Sacc., and *Corticium solani* Bourd. et Galz. from *Pteris longifolia* L. and *Pteridium equilinum* Kühn no serious study of these plants has been undertaken so far.

Rizosphere effect of pteridophytes, represented by members belonging to the Equisetaceae, Cyatheaceae and Polypodiaceae are presented here. Live specimens of *Equisetum* sp., *Lastrea* spp., *Pteris* spp. and *Cyathea* sp. were collected from high altitude plantation areas in the Nilgiri Hills and specimens of the garden varieties, *Pleopeltis* sp. and *Adiantum* sp., were collected at Madras. Methods followed for rhizosphere analysis are those detailed by Agnihotrudu.<sup>6</sup>

Results indicate (Fig. 1) that factors known to influence a definite flora in the root region of

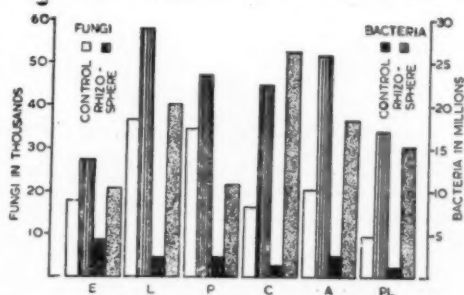


FIG. 1. Showing the rhizosphere microflora of pteridophytes. E—*Equisetum* sp.; L—*Lastrea* spp.; P—*Pteris* spp.; C—*Cyathea* sp.; A—*Adiantum* sp. PL—*Pleopeltis* sp.

angiosperms appear to equally well apply to pteridophytes. It is generally agreed that stimulation of microfloras in the root region of many angiosperms is due to the nature and amount of root exudates and sloughed off root material.<sup>2</sup> From a perusal of the data obtained here, it seems appropriate to make out a similar case for pteridophytes.

Quantitatively, fungal and bacterial numbers in the rhizosphere of the four genera studied were in the order of *Lastrea* > *Adiantum* > *Pteris* > *Equisetum*. Qualitatively, the flora showed a significant increase in *Penicillium* spp. and *Aspergillus* spp., but the interesting feature of the investigation was the frequent isolation of *Trichoderma* spp., often overgrowing other species of fungi in culture. Pathogenic forms like *Fusarium* spp. were infrequently found in

soil dilutions as well as root plating but were not consistent.

This study, therefore, opens out a new field for investigation to soil mycologists with pteridophytes in the temperate climate of our hill stations as well as in the subtropical soils in an attempt to correlate the occurrence of pathogenic fungal forms and incidentally problems of root exudates of this group of plants and their utilization by soil fungi.

I am deeply indebted to Prof. T. S. Sadasivan and Dr. C. V. Subramanian for advice and to the University of Madras, for the award of a studentship.

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## CYTOLOGICAL STUDIES IN INDIAN MOSESSES

### V. *Physcomitrium japonicum* (Hedw.) Mitt. and *Physcomitrium* sp.

IN earlier papers in this series Pandè and Chopra<sup>1-4</sup> reported the cytology of twenty-five mosses. Chopra<sup>5</sup> worked out the chromosome number of some Bryaceae.

*Physcomitrium japonicum* (Hedw.) Mitt. was collected from Nainital during the month of August while *Physcomitrium* sp. has a restricted but a luxuriant growth in the compound of the historic Residency building during the months of July-September. The material for the present study was fixed in acetic-alcohol (1:3) and the observations are based on usual actocarmine squash method.

*Physcomitrium japonicum* (Hedw.) Mitt.—In antheridial squashes 18 chromosomes were counted at metaphase. Three chromosomes have middle attachment and are V-shaped while the remaining 15 show terminal attachment and are rod-like (Fig. 1). In several sporocytes 18 bivalents were counted at metaphase I. Three pairs are conspicuously larger

than the remaining 15 pairs (Figs. 2-3). Meiosis follows the normal course.



FIGS. 1-3 *Physcomitrium japonicum* (Hedw.) Mitt. Fig. 1 18 chromosomes at metaphase in antheridial cells. Figs. 2-3 18 bivalents at metaphase I.

FIGS. 4-11. *Physcomitrium* sp. Fig. 4. 3 chromosomes at metaphase in antheridial squash. Figs. 5-6. 3 bivalents in A type at metaphase I. Figs. 7-8. 6 bivalents at metaphase I in B type. Fig. 9. Anaphase I in A type. Fig. 10. Telophase I in A type. Fig. 11. Anaphase I in B type.

*Physcomitrium* sp.—In antheridial squashes three chromosomes were counted at metaphase. One of the chromosomes has middle while the remaining two show terminal attachment (Fig. 4).

In single capsule squash, the author, to his great surprise, observed two types of sporocytes

named as 'A' and 'B' showing a marked difference in size. In 'A' sporocytes three bivalents were regularly counted at metaphase I (Figs. 5-6) while in 'B' type 6 bivalents were counted at diakinesis (Fig. 7) and metaphase I (Fig. 8). In both types of sporocytes there is no morphological difference in the chromosome pairs.

Meiosis was followed in both types of sporocytes. Three and six chromosomes were counted at both anaphase I and telophase I in A and B respectively (Figs. 9-11). Meiosis follows the normal course in both types of sporocytes.

The origin of polyploid sporocytes can reasonably be attributed to the premeiotic disturbance in the archesporial cells in the early stage of capsule development. The premeiotic disturbance might have been caused by the sudden change in temperature which resulted in the breakage of the spindle.

As far as the author is aware  $n=3$  is the smallest chromosome count ever reported in mosses.

Table I shows the chromosome counts in genus *Physcomitrium*. Evidently there is a high degree of polyploidy in *Physcomitrium pyriforme*,

TABLE I

| Name of the plant          | $n$     | Author                        |
|----------------------------|---------|-------------------------------|
| Genus <i>Physcomitrium</i> |         |                               |
| <i>P. pyriforme</i>        | 18      | Schmidt <sup>6</sup>          |
| do.                        | 9       | Pandè and Chopra <sup>1</sup> |
| do.                        | 27      | Brynn <sup>7</sup>            |
| <i>P. curvistomum</i>      | 9       | Sannomiya <sup>8</sup>        |
| <i>P. japonicum</i>        | 18      | Chopra (present study)        |
| <i>P. sp.</i>              | 3 and 6 | do.                           |

the basic number being nine with tetraploid and hexaploid races. It is possible that the basic number for the genus *Physcomitrium* is 3 and the other species are the polyploids, originated in the speciation of the genus from the parent stock with  $n=3$  or species with  $n=3$ ,  $n=9$ ,  $n=18$  have a parallel evolution in the origin of species of the genus *Physcomitrium*.

The author is extremely thankful to Dr. S. K. Pandè, D.Sc., of Lucknow University, under whose guidance this study was taken up and to Prof. S. N. Das Gupta for facilities and encouragement.

Birbal Sahni Institute of  
Palaeobotany,  
Lucknow,  
September 17, 1958.

NARINDER CHOPRA.

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#### A TECHNIQUE FOR STUDYING pH CHANGES PRODUCED BY CELLULOLYTIC FUNGI IN CELLULOSE SUBSTRATE

THE ability of cellulolytic micro-organisms to produce acid during digestion of cellulose substrates is well known and indeed, has been employed as the basis for the detection of their activity on various cellulosic material. Whilst, it may be useful to study the changes in pH in the cellulose substrate which are attacked by different cellulolytic micro-organisms, none of the existing methods lend themselves suitably to such an investigation. The primary difficulty seems to be in the availability of a pure cellulosic material in which pH changes can be readily studied. A cellulose medium incorporated with agar and a dye, commonly employed,<sup>1</sup> would hardly fulfil the purpose of a pure cellulose substrate. Another difficulty encountered is the inability of some micro-organisms to decompose filter-paper cellulose. Recent work by the author<sup>2</sup> has shown that although many species of *Fusarium* were unable to breakdown filter-paper they readily decomposed bacterial membranes synthesized by *Acetobacter xylinum* which is known to be a pure form of cellulose. It was also observed that the technique of employing bacterial cellulose as substrate for determining cellulolytic activity could be employed usefully for studying pH changes occurring in the substrate during the growth of micro-organisms.

Cellulose discs were prepared as described earlier.<sup>2</sup> After autoclaving, one such disc was placed in a sterile 10 cm. Petri dish and inoculated in the centre with *Fusarium culmorum* (test organism). Duplicate series, each with three inoculated dishes and three uninoculated controls, were maintained for each treatment. After incubation the cellulose discs with the fungal colony and the uninoculated controls in one series were treated with B.D.H. Universal Indicator. A few drops of the indicator solution was gradually pipetted on the membrane so as to cover the entire surface, the excess

drained off and after 10-15 minutes interval the dishes were held over a white background in good light and the colour produced in the substrate matched with the corresponding colour chart. The colour developed gave the approximate range of pH variations in the substrate. The narrow range indicator, specific for the range of pH observed, in the cellulose substrate, was then used on the duplicate series of discs. A gradient in colour change was seen to occur, beginning from the point of initial growth of the fungus to the periphery of the mycelium. The original pH of the substrate at 6.0 changed to 5.0-5.5 in the area covered by *F. culmorum* colony after 5 days' growth at 25-29° C. Acidity was greatest in the centre of the disc and gradually decreased up to the periphery of the colony, the pH remaining unaltered therefrom. The acid secreted by the growing mycelium of the fungus did not diffuse to a point further than 3-5 mm. from the hyphal tips. The technique was found to be simple, accurate and had the advantage of employing pure cellulose as substrate. The initial pH as well as the nutrient status of the substrate were also readily modified by altering the composition and pH of the mineral solution to which the bacterial membranes were treated<sup>2</sup> prior to inoculation. When the initial reaction of the membranes was adjusted to pH 3.0, 4.0, 5.0, 6.0, 7.0, 8.0 and 9.0, the substrate under 5-day old colony of *F. culmorum* had a pH of 4.0, 4.5, 4.5-5.0, 5.0-5.5, 5.0-5.5, 6.5-7.0, 7.0-7.5 respectively.

This work was carried out at the University Botany Laboratory, Madras. The author thanks Prof. T. S. Sadasivan for his criticism and interest in this work and the Government of India, for the award of a National Research Fellowship.

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December 6, 1958.

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# OCCURRENCE OF DIATOMS IN THE LEAF OF SPIRODELLA POLYRRHIZA SCHLEID.

WHILE examining the section of the leaves of *Spirodella Polyrrhiza* (an aquatic plant of the family Lemnaceae, which was growing abundantly in the Laboratory lysimeters of the Botany Department of Annamalai University) diatoms were found to occur in the cells of the

upper epidermis, air-cavities and also inside the mesophyll tissues. These diatoms were of semi-lunar configuration with prominent raphe exhibiting sluggish movement. The older the leaf the more the number of diatoms it contained. Dead leaves contained the maximum number and the youngest had practically none. Slow dying of *Spirodella Polyrrhiza* in the lysimeter was noticed and the complete extinction of the plants occurred within a month. Perhaps the entry of the diatoms in the leaf tissue might have adversely affected the metabolism of the plant and brought about its death.

The diatoms "Cymbella" were the main inhabitants, though a few other types of diatoms were also there. So far endophytic type of diatoms in aquatic plants have not been observed and recorded.

The author is grateful to Dr. T. C. N. Singh and Prof. M. O. P. Iyengar who confirmed the above finding.

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December 15, 1958.

# VASCULAR SUPPLY FOR THE STIPULE IN CAYRATIA CARNOSA GAGNE?

ACCORDING to Sinnott and Bailey,<sup>1</sup> each stipule obtains its vascular supply from the branches derived from the corresponding lateral traces of the associated leaf. Majumdar,<sup>2-3</sup> after reviewing the past work on stipules concluded that the laterals after their departure from the axial cylinder run parallel through the axial component (the foliar foundation when wholly included in the shoot axis is termed by him as the axial component) and shift towards the median. He also concluded that if these laterals branch, they give rise to the stipules. Following observations will indicate that even in the absence of the branching of the laterals, stipular initiation can occur.

The writer in the course of his investigations on origin and development of stipules in some species of Vitaceae observed a type of stipular vascular supply in *Cayratia carnosa* (syn. *Vitis trifolia* L.), which, as far as he is aware, is hitherto not reported. Figure 1 shows a first foliar primordium ( $L_1$ ) and the two lateral swellings (X), formed by periclinal divisions in the axis, which are the earliest signs of stipular initiation observed. The second leaf and its stipules typifying a later stage arise as a three-lobed structure, the central one giving rise to the petiole and the blade and the lateral lobes as

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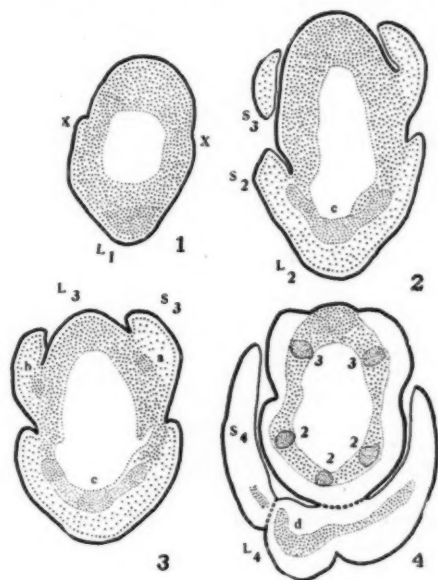
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stipules. Figure 4 shows that the leaf receives three trace bundles, one median and the two laterals. The most interesting fact is the behaviour of the two laterals. These two traces as they depart from the axis enter the stipular

T. C. N. Singh, Head of the Department of Botany, for facilities.

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September 27, 1958.

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FIGS. 1-4. Serial transverse sections of shoot apex showing the leaves ( $L_1$ ,  $L_2$ ,  $L_3$  and  $L_4$ ) and their respective stipules ( $S_1$ ,  $S_2$ ,  $S_3$  and  $S_4$ ) from the terminal apex,  $\times 290$ . a, b—Indistinct lateral traces for the third leaf; c—vascular supply of the second leaf and its stipule; d—vascular tissue of the fourth leaf and its stipule; 2—procambium strands of the second leaf-trace; 3—procambium strands of the third leaf-trace.

tissue and traverse obliquely (Figs. 2, 3). They converge with the median one, opposite the leaf-base and form the foliar vascular supply (Figs. 2, 3, 4). It is evident that the initiation and development of the stipules at this stage are due to the stimulating influence of the two laterals. Sinnott and Bailey<sup>1</sup> have correctly emphasised the morphogenetic connection between lateral leaf-trace and stipule. But the most significant observation is that the stipular initiation is not due to any vascular supply that arises as a branch from the lateral trace of the leaf. In fact the stipular primordia in their early stages appear as if they were the two basal lobes of the leaf, vascularised by the lateral traces. The fuller details and discussions will be published elsewhere.

My sincere thanks are due to Professor

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# A NOTE ON THE CHROMOSOMES OF *ORYZIAS MELASTIGMA* (McCLELLAND)

AMONG the vertebrates, as Bungenberg<sup>1</sup> has pointed out, the fishes are the least known cytologically, owing to technical difficulties and to small size of the chromosomes. Of the 560 species of cytologically known vertebrates, only about 95 are fishes and according to Makino<sup>2</sup> these do not include a single Indian species.

The present note describes the chromosomes of *Oryzias melastigma* from squashes and from sections of early cleavage stages. The chromosome number has been determined from metaphase plates.

There are 24 pairs of chromosomes. Of these 7 pairs are acrocentrics. Of the metacentric chromosomes, 12 pairs are 'V'-shaped with more or less equal arms and with median centromeres. The remaining 5 pairs are 'J'-shaped, one pair with median centromere, the rest all having subterminal centromeres. All the chromosomes are well defined, no heterochromosome being present.

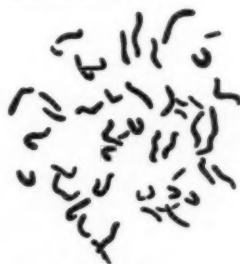


FIG. 1. Camera lucida drawing of the metaphase chromosomes of *Oryzias melastigma*—acet.-orcein squash,  $\times ca. 2,000$ .

The chromosome number in different species of Cyprinodonts varies from  $2n = 36$  to 48. The chromosome complement of *Oryzias melastigma* is similar to that of the Japanese species *Oryzias latipes*.  $2n = 48$  is also found in *Xiphophorus hellerii* and *Platypecilus maculatus*.

In the metaphase plates the chromosomes appear to be telomitic and atelomitic structures with median, submedian and subterminal centromeres. But the morphological nature of these

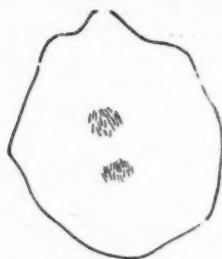


FIG. 2. Camera lucida drawing of the early anaphase chromosomes of *Oryzias melastigma*—one optical section represented,  $\times$  ca. 6,500.

chromosomes during early anaphase presents a different picture. The chromosomes during the early anaphase appear as clearly rod-shaped structures of varying lengths in contrast to the telomitic and atelomitic metaphase chromosomes with submedian and subterminal centromeres. Makino<sup>2</sup> has pointed out that the strongly curved and 'V'-shaped appearances of the metaphase chromosomes of Stickleback is only a temporary phase. The present study also indicates that the metaphase curving does not indicate the real nature of the chromosomes which are really rod-shaped as the anaphase reveals.

My thanks are due to Professor R. V. Seshaiya, Director, Marine Biological Station, Portonovo, for suggesting the problem and for guidance and instruction, and to Government of India, Ministry of Education, for the award of a Senior Research Scholarship.

Department of Zoology, VIJAYAM SRIRAMULU,  
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### INDEPENDENT ORIGIN AND DEVELOPMENT OF THE CRYSTAL- LINE LENS IN *GASTEROSTEUS* *ACULEATUS* (L.)

THE experimental work on Amphibia<sup>1,4</sup> shows that if the eye cup is removed at the tail bud stage, the lens is not formed. Further, the eye cup induces the formation of a lens out of epidermal tissue which would normally not have given rise to a lens at all. It is, therefore, concluded that the formation of the vertebrate lens is under the influence of the eye cup. However, there are a few exceptions. When the developing eggs of *Fundulus heteroclitus* are subjected to the action of magnesium salts, alcohol or other anaesthetic agents, the normal outgrowth of the optic vesicles is generally inhibited but the lens does differentiate from the epidermis.<sup>5</sup> In *Rana esculenta*, the removal of the eye rudiment at the early neural fold stage does not prevent the formation of a lens.<sup>6</sup> A similar effect is produced when the eggs of *R. esculenta* are treated with low temperatures and the lens is formed in the absence of an eye cup.<sup>7</sup>

*Gasterosteus aculeatus* resembles *F. heteroclitus* and *R. esculenta* in this respect as shown by the present experiment.

The adult specimens of *G. aculeatus* were obtained from a near-by pond at Oxford and brought to maturity in the laboratory aquaria.

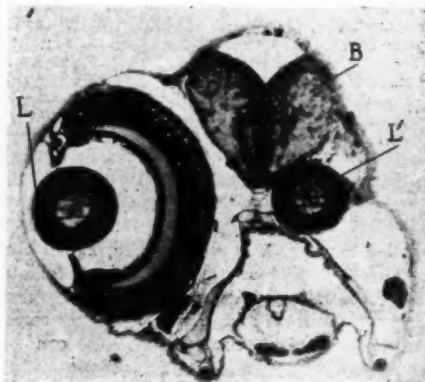


FIG. 1. Transverse section of the larva of *Gasterosteus aculeatus* showing monophthalmic condition. Mag.,  $\times$  108. B = Brain, L = Lens of normal eye, L' = Lens developed without the eye cup.

The eggs stripped from a ripe female were fertilized by the dry sperm method of artificial insemination and immediately after, were subjected to cold or hot shock treatments. For

cold shock, the eggs were subjected to a temperature of 0° C. for three hours and for hot shock to a temperature of 32.5-37° C. for five minutes. The treated eggs were then allowed to develop in an apparatus specially constructed for the purpose.<sup>8</sup> The embryos which hatched out showed various types of microcephaly. It is interesting to note that monophthalmic condition was produced only in the embryos developed from the cold shocked eggs. One such embryo showing monophthalmic condition developed into an advanced larva. A section passing through the eye region of this larva (Fig. 1) shows that the lens has developed in spite of the fact that the eye cup of that side is absent. The following peculiarities have been noted in the present case:

- (i) The self-differentiated lens is but very slightly smaller in size than the normal one.
- (ii) The part of the brain which should have differentiated the eye cup is almost normal.
- (iii) The self-differentiated lens is touching the brain on one side and the epidermis on the other.

An event of this nature may be explained in one of two ways. The determination of the lens occurs precociously, i.e., the lens is determined by the presumptive eye rudiment at an early neural plate stage. The second explanation is that the optic lens may be looked upon as a once independent organ which has become closely associated with the nervous elements of the eye, that it has to some extent lost its tendency to arise independently, although still capable of doing so under certain conditions.

My thanks are due to Professor Sir Alister Hardy, F.R.S., and Dr. M. Fischberg, for their kind help and facilities in the Department of Zoology and Comparative Anatomy, Oxford.

Department of Zoology, H. SWARUP.  
University of Saugar,  
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# **OCCURRENCE OF MONONCHUS SP. (FAM. MONONCHIDÆ: TRIPYLOIDEA) A PLANT NEMATODE FROM INDIA**

SOMETIME ago the Superintendent, Wynaad Colonization Scheme, Ambalavayal, Kerala State (South India), reported to the Zoological

Survey of India decline of Mandarin orange trees and sought the help of the Department in identifying the round worms suspected to be responsible for the decline. It was stated that the declining orange trees invariably developed a sort of root peeling and root rot, and microscopic examination of the affected roots disclosed the association of round worms. It was reported that these worms manifested themselves soon after the monsoon set in that region. It was further stated that the foliage showed signs of yellowing and that worms were far less in number in trees well manured, the roots of which were protected by plenty of organic matter than in poor soil and unattended trees.

The mandarin orange roots were examined in detail after the receipt of the material from the above authorities. The root peeling and root rot were observed. When these root peelings and root rots were teased and examined under the microscope, they were found to contain round worms associated with certain arthropod larvae and some minute earthworms. The worms were found to infest even the finest rootlets. The epidermal layer of the roots were also found to get lacerated and torn and ultimately the bark of the roots peeled off in very fine layers. The worms were found in large numbers in roots which showed signs of rot and disintegration and comparatively less in roots which did not show any decline.

These round worms (eel worms) are identified as *Mononchus* sp., a predatory nematode, belonging to the genus *Mononchus* Bastian, 1865. Though the species of *Mononchus* appear to be of common occurrence all over the world, this worm has been recorded for the first time from India.

The author wishes to convey his thanks to Dr. B. S. Chauhan, Officer-in-charge, Helminthology Section of the Zoological Survey of India, for encouragement and guidance, to Dr. J. B. Goodey of Rothamsted Experimental Station (U.K.), for the identification and to the Superintendent, Wynaad Colonization Scheme, Ambalavayal, for having supplied the material.

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# ACTIVATION OF PIGEON PANCREATIC LIPASE BY MERCURIC CHLORIDE

THE occurrence of a lipase in the *Pectoralis major* muscle of the pigeon was reported in an earlier paper.<sup>1</sup> Subsequently it was decided to study the properties of this lipase and the pancreatic lipase of the same animal with a view to comparing them. A detailed account of the study is reserved for a future communication. Here we report the behaviour of the pancreatic lipase in the presence of mercuric chloride. Barron and Singer<sup>2</sup> have classified pancreatic lipase and esterases under sulphhydryl enzymes. Ions of heavy metals such as Hg are said to inactivate such enzymes by combining with reactive —SH groups forming mercaptide compounds. Such inactivation can be reversed by the addition of BAL\*,<sup>2</sup> because of its greater affinity for the metal. In our attempt to confirm this in the case of the pancreatic lipase of the pigeon we found, contrary to our expectation, that small concentrations of the metal activates the enzyme to the extent of 600% and is inactivated by BAL.

The enzyme we used in our study was an aqueous extract of ether defatted dry powder of the pigeon pancreas. The pancreas removed after decapitating the animals was cut into small pieces and dried at room temperature *in vacuo* over calcium chloride. Dehydration was complete within 24 hrs. The dry tissue was turned into a powder by crushing in a mortar, sieved through fine silk, treated with a large quantity of cold ether for 1 hr., filtered and dried at room temperature till all the ether was removed. 10 mg. of this powder was extracted in 5 ml. distilled water in cold for 1 hr., centrifuged at about 2,500 r.p.m. and the supernatant used as the enzyme solution. One ml. of this extract contained 0.6–0.7 mg. protein. The nitroprusside reaction and the lead-blackening test gave negative results with this extract indicating the absence of —SH or —S—S—groups. BAL formed an insoluble blue green precipitate with this solution which according to the description of Webb and van Heyningen<sup>3</sup> is a BAL-iron compound. The precipitate was ashed and the ash taken up in 3 N HCl. This solution was found to contain large quantities of iron.

The lipolytic activity of the extract was manometrically determined according to the method followed in an earlier study.<sup>4</sup> The activity of the enzyme at different concentrations of the

mercuric chloride is shown in Figs. 1 and 2. The mercuric chloride used was a recrystallized pure sample. All the other chemicals used were of analytical grade.

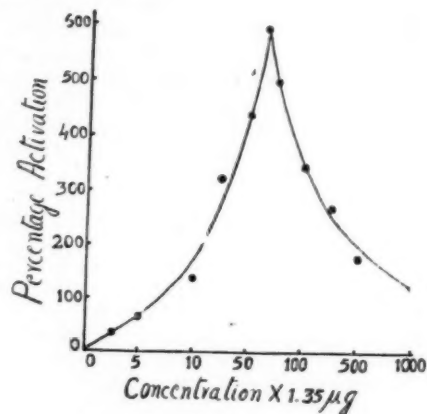


FIG. 1. Activation of pigeon pancreatic lipase by mercuric chloride at low concentrations.—Bicarbonate-CO<sub>2</sub> buffer, pH 7.4, temp. 37°C., gas phase 95% N<sub>2</sub>+5% CO<sub>2</sub>. Flask contents—1.5 ml. 0.025 M NaHCO<sub>3</sub>, 0.5 ml. HgCl<sub>2</sub> to give the above concentration and 0.5 ml. enzyme in the main chamber and 0.5 ml. 4% tributyrin in 0.0148-M NaHCO<sub>3</sub> emulsified with Tween 80 in the side arm, in a total volume of 3 ml. Control flask had 0.5 ml. H<sub>2</sub>O in place of HgCl<sub>2</sub>. Duration of the experiment 1 hr.

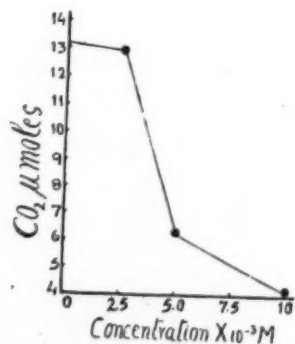


FIG. 2. Inhibition of pigeon pancreatic lipase by mercuric chloride at high concentrations. Conditions same as for Fig. 1.

It can be seen that the activation is maximum between concentrations 90–100 μg. of the salt. This increase in activity of the enzyme was also found when the enzyme was pre-incubated with the same concentrations of the salt. Thereafter the activity decreases with increasing concentra-

\* Abbreviations used—BAL, British-Anti-Lewisite (2:3-dimercaptopropanol), PCMB, *p*-chloromercuribenzoate.

tions of mercuric chloride. Even at a final concentration of  $10^{-2}$  M in the 3 ml. content of the flask the inhibition is only 66%.

Activation of an enzyme by mercuric chloride is something unknown. No attempt has been made to study the physical chemistry and chemical kinetics of this activation. It should be noted that PCMB at all concentrations is inhibitory. Complete inhibition was obtained at a final concentration of  $2 \times 10^{-3}$  M in the reaction flask. The inhibition by PCMB and mercuric chloride at high concentrations is not due to the formation of mercaptides because it was found that the enzyme does not contain any trace of sulphur. The usefulness of these substances in the detection of —SH groups in protein is therefore limited. Barron<sup>2</sup> has reported that heavy metals which form mercaptide can also combine with the  $\text{NH}_2$  groups of protein. However the activation of the pigeon pancreatic lipase by mercuric chloride at low concentrations is difficult to explain. May be that it binds some inhibitors already present in the extract and brings about an activation.

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**EFFECT OF INSULIN INJECTION ON THE AMINO NITROGEN CONTENT OF FREE AND PROTEIN-BOUND AMINO-ACIDS IN THE SKELETAL MUSCLE OF THE MURREL—OPHICEPHALUS STRIATUS (BLOCH)**

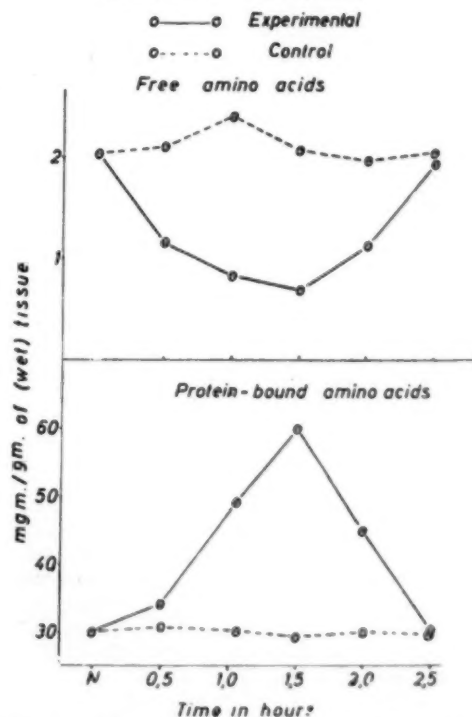
LOTSPEICH,<sup>1</sup> who studied the effect of insulin injection on the amino-acids of blood and muscle in the dog, found that there was a proportional correlation between the fall of the free amino-acids in the blood and the rise of protein-bound amino-acids in the muscle following the injection of insulin. From this he concluded that insulin promotes protein synthesis. Best *et al.*<sup>2</sup> have pointed out that evidence indicating that insulin promotes protein anabolism has been accumulating in recent years.

The effect of insulin on the carbohydrate and protein metabolism in the fish *Ophicephalus striatus* (Bloch), has been studied. A cold-blooded animal is in some respects better suited for these studies than mammals. Observations show that following injection of insulin, the amino nitrogen of the free amino-acids shows a fall, and this is accompanied by a corresponding rise in the amino nitrogen of the protein-bound amino-acids of the muscle of the fish.

Intra-muscular injection of 5 units of insulin was given to specimens weighing about 150 to

**AMINO NITROGEN - MUSCLE**

*Ophicephalus striatus* (Bloch)



200 gm. As control experiments a separate batch of fish were injected with 2.5 ml. of distilled water. At the end of 0.5, 1.0, 1.5, 2.0 and 2.5 hours after insulin injection the specimens were dissected and the skeletal muscle weighing about 0.2 gm. was immediately taken for analysis. Extracts were prepared following the procedure adopted by Russel and Long<sup>3</sup> for the estimation of amino nitrogen of free amino-acids. Tissues were hydrolysed with 6N HCl and extracts were prepared following the method adopted

by Giri *et al.*<sup>4</sup> Amino nitrogen estimations were carried out following Pope and Stevenson's method as modified by Block and Bolling<sup>5</sup> and values were expressed in mgm./gm. of tissue. Four sets of experiments were carried out for each stage and the mean values are represented in the graph.

The percentage of fall of the amino nitrogen of the free amino-acids, the percentage of increase of that of protein-bound amino-acids and the percentage of recovery of both are shown in Table I.

TABLE I

| Amino nitrogen   | Duration (in hours) after insulin injection |       |       |       |       |
|------------------|---|-------|-------|-------|-------|
|                  | 0.5   | 1.0   | 1.5   | 2.0   | 2.5   |
| Free amino-acids | 48.16                                       | 58.83 | 60.89 | 56.39 | 95.10 |
|                  | F   | F     | F     | R     | R     |
| Protein-bound    | 13.70                                       | 63.76 | 83.23 | 50.57 | 95.00 |
|                  | I   | I     | I     | R     | R     |

F: % of fall. I: % of increase. R: % of recovery.

Graph shows the effect of insulin injection on the amino nitrogen of free and protein-bound amino-acids. For the free amino-acids, the decline of the amino nitrogen lasts for 1.5 hours when the amino nitrogen content is at a minimum. This declining phase is followed by the recovery phase. At the end of 2.5 hours following the injection, the amino nitrogen content of the free amino-acids recovers to about 95.10% of the normal value. It will be seen that in the control experiments there is no significant change in the amino nitrogen content of free amino-acids.

With regard to the protein-bound amino-acids, the amino nitrogen content increases after injection. At the end of 1.5 hours—the maximum is reached showing an increase of 83.23%. Then the decline towards normality follows, the amino nitrogen recovering to 95.0% of the normal value.

The graph shows the striking parallel between the progressive fall and recovery of the amino nitrogen of the free amino-acids on the one hand and the progressive increase and decline of that of the protein-bound amino-acids. The correspondence is sufficiently close and significant to warrant the inference that the injection of insulin increases the synthesis of protein at the expense of the free amino-acids in the skeletal muscle. The reverse process evidently occurs during the recovery to normality.

My thanks are due to Professor R. V. Seshaiya, Director of Marine Biological Station, Portonovo,

for suggesting the problem and for guidance. My thanks are also due to the Ministry of Education, Government of India, for the award of a Senior Research Scholarship.

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#### AGE-DETERMINATION OF THE INDIAN OIL-SARDINE, *SARDINELLA LONGICEPS* VAL. BY MEANS OF SCALES\*

DIVERGENT opinions have been expressed in the past regarding the age of the Indian oil-sardine.<sup>1-5</sup> Recent work on some Indian fishes has shown that the scales can be used for age-determination. A detailed study of the scales of the oil-sardine was, therefore, undertaken to see the extent to which they could be utilized for determining the age of the fish.

The material for the work was collected at Calicut from January 1957 to August 1958. A careful examination of the scales of the different regions of the body of the fish was made on the same lines as was done by Phillips<sup>6</sup> on *Sardinops caerulea*. It was observed that the scales from the region just above the tip of the pectoral fin were the most reliable for this work and accordingly six scales from each of 1,370 specimens were studied in detail.

The disposition of circuli in the scales was more or less horizontal. The centre or the focus of the scale was not quite distinct. A ring, when present, was seen as a semicircular mark concentric with the scale-margin and breaking the continuity of the circuli; occasionally, a ring might be broken into segments. While generally well-defined, the rings were not quite clear in a few cases. Besides the true rings, certain false-rings, similar to those described by Walford and Mosher<sup>7</sup> in *Sardinops caerulea*, were noticed in a few scales.

\* Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

No. of fish

No. of rings

Average

It is from the any ring value of increasing two and the sizes pectively up to 16 thereafter scales b observed May-Jul formed c in the l be in th

The p studied at 12.0, and at For 1957 16.0 cm. to the fish in t

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TABLE I  
Table Showing Distribution of Rings

Size-groups (in cm.)\*

|                      | 7-0<br>to<br>7-9 | 8-0<br>to<br>8-9 | 9-0<br>to<br>9-9 | 10-0<br>to<br>10-9 | 11-0<br>to<br>11-9 | 12-0<br>to<br>12-9 | 13-0<br>to<br>13-9 | 14-0<br>to<br>14-9 | 15-0<br>to<br>15-9 | 16-0<br>to<br>16-9 | 17-0<br>to<br>17-9 | 18-0<br>to<br>18-9 | 19-0<br>to<br>19-9 | 20-0<br>to<br>20-9 | 21-0 |
|----------------------|------------------|------------------|------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|------|
| No. of fish examined | 4                | 10               | 7                | ..                 | ..                 | 110                | 349                | 301                | 103                | 144                | 163                | 114                | 41                 | 24                 |      |
| No. of rings 0       | 4                | 10               | 3                | ..                 | ..                 | 33                 | 142                | 120                | 18                 | 5                  | 1                  | 1                  | ..                 | ..                 |      |
| 1                    | ..               | ..               | 4                | ..                 | ..                 | 74                 | 206                | 177                | 67                 | 71                 | 49                 | 24                 | 6                  | 3                  |      |
| 2                    | ..               | ..               | ..               | ..                 | ..                 | 3                  | 1                  | 4                  | 17                 | 67                 | 93                 | 75                 | 30                 | 15                 |      |
| 3                    | ..               | ..               | ..               | ..                 | ..                 | ..                 | ..                 | ..                 | 1                  | 1                  | 20                 | 14                 | 5                  | 6                  |      |
| Average No. of rings | 0                | 0                | 0.57             | ..                 | ..                 | 0.73               | 0.60               | 0.61               | 1.01               | 1.44               | 1.80               | 1.90               | 1.98               | 2.13               |      |

\* Total length from tip of snout to tip of dorsal caudal fluke.

It is obvious from Table I that the scales from the sardine below 8.9 cm. do not have any ring and that above that size the average value of the rings increases in general with the increasing size of the fish. Scales with one, two and three rings make their appearance at the sizes of 9-9.9, 12-12.9 and 15-15.9 cm. respectively. The one-ring class predominates up to 16-16.9 cm. group and the two-ring class thereafter, the fish with three rings in their scales being small in number. It has been observed that the period of ring formation is May-July and it appears that only one ring is formed every year. The presence of three rings in the large-sized fish suggests that they may be in the fourth year of their life.

The percentage length-frequency distribution studied separately indicates three distinct modes at 12.0, 16.0, and 18.0 cm. for the year 1955-56 and at 12.0, 17.0 and 19.0 cm. for 1956-57. For 1957-58 there are two modes at 13.0 and 16.0 cm., the third mode being not clear owing to the absence of adequate number of large fish in the catches.

It is evident from the above that the results obtained by length-frequency analyses and study of scale-rings of the fish are in agreement to some extent. It may, therefore, be reasonable to assume that these rings may prove useful in the determination of the age of the sardine. The work is in progress and details will be published in due course.

My grateful thanks are due to Dr. N. K. Panikkar, Dr. S. Jones, Shri R. V. Nair and Dr. G. Seshappa for their valuable suggestions and helpful criticism.

Central Marine Fisheries Research V. BALAN.  
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August 25, 1958.

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#### CHANGES IN THE FREE AMINO ACIDS OF RICE SEEDLINGS INDUCED BY LOW TEMPERATURE AND H<sub>2</sub>S

ONE of the major problems of rice producing countries is the periodical outbreak of the so-called "browning disease" of rice (brusone, aki-ochi). According to the prevailing opinion the disease is caused by the fungus *Piricularia oryzae*. However, an important role must be attributed to some environmental factors favouring disease development, like abundant N-supply, lack of sunshine combined with low temperature, increase of H<sub>2</sub>S in soil. Under these circumstances the fungal infection appears secondarily when a "physiological weakening" of the host plant has already taken place.<sup>1</sup> Of the factors favouring disease development the effect of low temperature (12 to 14°C.) and H<sub>2</sub>S on the free amino acid content of rice seedlings was subjected to detailed studies. These investigations were warranted by a number of observations made by earlier authors on disturbances in N-metabolism in diseased plant tissues. In plants infected with facultative parasites often a shift of the ratio, soluble N/protein N, has been found.<sup>2</sup> Therefore, a study of the effect of the abovementioned factors favouring the outbreak of disease has been undertaken in order to find

out whether or not a change of a similar nature could be observed in plants predisposed to disease.

Rice seedlings were grown in sand culture for 16-18 days and then transferred for the experiments to a modified Hoagland solution at pH 6.5. The quantitative assay of amino acids was carried out as previously described.<sup>3</sup>

The changes in amino acids due to low temperature are essentially the same as those characteristic to plant tissues attacked by parasites. The abnormal accumulation of basic amino acids, playing a major role in protein synthesis, seems to be of particular interest (glutamic and aspartic acids and their amides). The amount of some other amino acids (alanine,  $\gamma$ -amino butyric acid, tyrosine, etc.) underwent practically no changes. As shown by our experiments the lowering of temperature resulted only in a partial inhibition of uptake of N-compounds by the seedlings. Therefore, the above results may be interpreted as to show that low temperature inhibits primarily the protein synthesis, whereas the conversion of inorganic N into amino acids has also been observed in the endosperm. This seems to indicate that the translocation of amino acids is more seriously inhibited by low temperature than their mobilisation.

The effect of treatment of rice seedlings with  $H_2S$  ( $H_2S$  was bubbled through the nutrient solution for 3 hours) gave entirely different results. In contrast to the findings of Mitsui

et al.<sup>4</sup> no uptake of N compounds was observed in  $H_2S$ -treated plants. However, as shown in Fig. 1, the relative amount of amino acids changed considerably. A comparison of the chromatograms A and C with D and F clearly indicates that some amino acids in the treated plants practically disappeared (glutamic and aspartic acids, glutamine) whereas the amount of some others slightly increased (alanine,  $\gamma$ -amino butyric acid). It is logical to hypothesize that the increase in these 2 amino acids is due to a transamination process, the amino groups being transferred from glutamine and aspartic acid.  $H_2S$  apparently did not inhibit transaminations. Therefore, the changes in N-metabolism induced by  $H_2S$  are different from those induced by low temperature, although both favour the outbreak of brusone. Further biochemical studies are necessary to elucidate the mechanism of action of the various factors playing a role in the development of the brownish disease of rice. Our own studies will be extended to an investigation of the effect of  $H_2S$  on the transaminase of rice *in vitro*.

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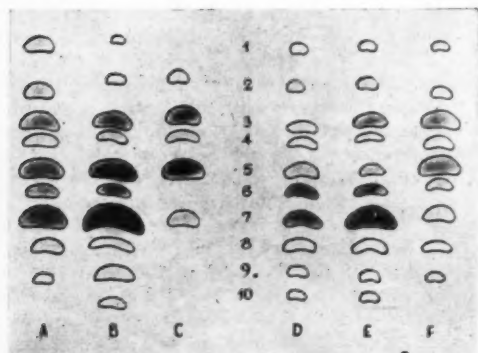


FIG. 1. The amino acids of root and leaf tissue. ABC = root, DEF = shoot, AD = control (start of experiment, before the transfer of seedlings to the nutrient solution) BE = plants in nutrient solution aerated for 3 hours, CF = plants in nutrient solution treated with  $H_2S$  for 3 hours. 1 = leucine, 2 = valine, 3 =  $\gamma$ -aminobutyric acid, 4 = tyrosine, 5 = alanine, 6 = glutamic acid, 7 = aspartic acid + glutamine, 8 = histidine, 9 = glutathione, 10 = cysteine.

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### TORULA STAGE OF HENDERSONULA TORULOIDEA NATTRASS ON TWIGGS OF PSIDIUM GUAJAVA L.—A NEW RECORD

FROM the twigs and branches of deciduous trees showing symptoms of wilting and die-back in Egypt, Nattrass<sup>1</sup> isolated the fungus *Hendersonula toruloidea* Nattrass and in 1933 described its *Torula* and pycnidial stages found in artificial media and nature. In 1947, Wilson<sup>2</sup> described the *Torula* stage of the fungus causing branch wilt disease of Persian walnuts in California, as *Erosporina fawcetti* Wilson, but later studies by him revealed that *E. fawcetti* sometimes forms pycnidia and it was the conidial stage of *H. toruloidea* Nattrass.

In the month of August 1957, twigs of guava (*Psidium guajava* L.) plants in an orchard near Kota (Rajasthan) were observed to show

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symptoms of die-back, drying and defoliation (Fig. 1). Isolations from affected tissues almost



FIG. 1. Diseased twigs of guava.

invariably yielded the pure culture of a fungus, which was studied and identified as *Torula* stage of *Hendersonula toruloidea* Nattrass.

On potato dextrose agar (2%) medium, the fungus starts with a white pulverulent aerial growth, later turning to smoke-grey and ultimately black in colour. The hyphae are 2.7-9  $\mu$

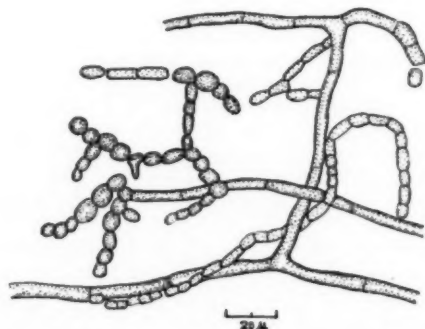


FIG. 2. Hyphae and conidia of *Hendersonula toruloidea* Nattrass.

broad, mostly septate, irregularly branched, hyaline when young, turning to olive to olive grey colour in 3 to 4 days. Short-branched convolute hyphae arise from the agar surface, become septate throughout their length

and produce chains of conidia (thallospores or arthrospores) in abundance within 48 hours of inoculation (Fig. 2). The conidia, when mature, are olive to olive brown in colour, smooth-walled, globose, ovoid, wedge-shaped, single-celled, 3.6-14.4  $\mu$  long (average 7.3  $\mu$ ) and 2.7-9  $\mu$  broad (average 3.9  $\mu$ ).

The fungus also grew and sporulated well on cornmeal, oatmeal, Brown's, Dox's and Richard's agar media. The optimum temperature for fungal growth was found to be between 30 and 35° C.

The fungus under study closely resembles *Torula* stage of *H. toruloidea* Nattrass. The pycnidial stage has not been found so far in nature or in our culture on artificial media. The culture has been deposited in the culture collection of the Mycology Division of the Indian Agricultural Research Institute, New Delhi.

Authors are grateful to the Director, Commonwealth Mycological Institute, Kew, for identification of the fungus, to Dr. N. Prasad, Plant Pathologist for his guidance and to Shri Samrath Raj, Director of Agriculture, for providing facilities of work.

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#### ROOT KNOT NEMATODE ON COLOCASIA

DURING autumn of 1957, 'root knot' like galls were observed on the roots and corms of *Colocasia antiquorum* Schott., at the Central Potato Research Station, Patna. Microscopic examination of the infested tissues revealed the presence of a large number of nematodes, which were identified to be *Meloidogyne javanica* (Treub) Chitwood. The only reference of 'root knot' on *C. antiquorum* is one of an unidentified species of *Meloidogyne* (formerly called *Heterodera radiculicola*) by Nagakura (1930). In India *C. antiquorum* was not mentioned as a host of 'root knot' nematodes by Baylis (1936), who reported them under *Heterodera marioni* (Cornu) Goodey, on a number of field crops.

The nematode infestation on the young roots appears as small irregular knots. In the older roots, the injury produces warts with local thickenings throughout their length. In cases of heavy infestation, thick prominent galls are

formed on the roots (Fig. 1). In the corms the infestation appears first as small tubercles, but

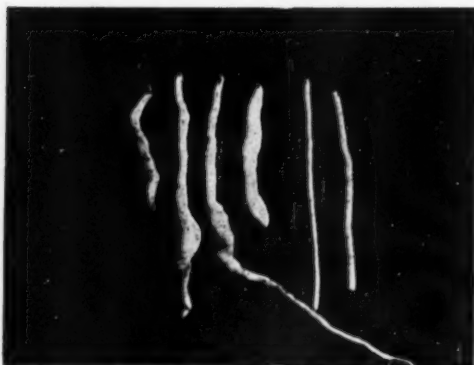


FIG. 1. Roots of *Colocasia antiquorum* Schott. Four on left infested by *Meloidogyne javanica* (Treub) Chitwood. Two on right free of infestation.

heavy and localised attack leads to gall formation (Fig. 2).



FIG. 2. Corms of *Colocasia antiquorum* Schott. One on left free from nematodes. Two on right infested by *Meloidogyne javanica* (Treub) Chitwood.

The galls were observed to be filled with pear-shaped adult females, numerous egg masses in different stages of development and a few males. Sometimes the glistening white females embedded in the tissues of *C. antiquorum* may be seen with the naked eye, when an infested corm is cut across.

I am grateful to Dr. Pushkarnath, Director, Central Potato Research Institute, Simla, for his keen interest and encouragement. My sincere thanks are also due to Dr. Mary T. Franklin of the Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, U.K.,

for the identification of the nematode and supply of valuable information.

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Central Potato Research Institute,  
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Patna, September 9, 1958.

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### USE OF HORMONES TO INDUCE ROOT GROWTH ON FRUIT PLANT CUTTINGS

QUITE a lot of our fruit and flower plants are propagated through cuttings, but some of them like sour lime and plum often do not strike roots so easily as others and to ensure their establishment such cumbersome and expensive methods as layering, goottee, and grafting have to be resorted to. Researches in other countries have pointed to the fact that treatment of cuttings with hormones induces rooting, but very little work has been done on this line in India. The propagation of grape (*Vitis vinifera*), sweet lime (*Citrus limettoides*), sour lime (*Citrus aurantifolia*), and plum (*Prunus domestica*) has been a great problem and therefore, such investigations were greatly wanting. It was in this background that the present experiments were conducted in a sandy loam field at Ludhiana during 1950 and 1951. A total of 9,600 cuttings of the above four fruit plants were used.

The cuttings were prepared from one year old wood of uniform length of about 9" with about the same thickness and carrying about the same number of buds. The cuttings in case of *Citrus* species were stripped of all the leaves. The treatments given to these cuttings were the application of (i) alpha-naphthalene acetic acid, (ii) 3-indole acetic acid, and (iii) B-3-indole propionic acid with a dose of 4,000 ppm. in Talc. powder.

To study the effect of various hormones on the rooting of these cuttings, time taken between callus formation and root formation and then, number, length and thickness of roots were studied. The data were analysed statistically, and the following results were arrived at from this investigation.

1. Callus formation in hormone treated cuttings took place earlier than in untreated ones and consequently rooting in almost all the fruit species under trial was hastened by about a week.

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2. Sweet lime and sour lime treated cuttings planted in the month of August gave rooting three weeks after the date of planting whereas the cuttings planted in February gave rooting 8 weeks after planting.

3. The roots on the hormone treated grape vine cuttings were found scattered all over the underground portion of the cuttings, whereas in untreated cuttings roots were confined to the basal portion of the cuttings.

4. In plum, sweet lime and sour lime, roots were confined to the basal portion of the cuttings in both treated and untreated.

5. There was greater number of roots and roots were longer and thicker in size and profusely branched on cuttings treated with hormones than on untreated cuttings of all the fruit plants under trial.

6. 3-Indole acetic acid in this respect was found to be the best hormone followed by B-3-indole propionic acid, and alpha naphthalene acetic acid, for grape vine and plum. In sweet lime also 3-indole acetic acid gave the best results followed by alpha-naphthalene acetic acid, B-3-indole propionic acid and control.

7. Although sour lime cuttings were induced to rooting by the hormone treatments to a certain extent the results were not encouraging.

The above information will prove useful for the progressive fruit growers as well as the nurserymen. The author will be glad to receive comments from any readers who may be working on similar problems or may be interested in this line.

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#### A SERIOUS ATTACK OF *SITOTROGA CEREALELLA* OLIV. ON STANDING CROPS OF CHOLAM AND RAGI AT COIMBATORE

*Sitotroga cerealella* Oliv. is an important pest found on stored grains of paddy, cholam and maize. It is also reported to attack stored wheat, barley, oats, etc., in other countries. The adult is a tiny-grey moth with fringed hindwings and often found in numbers flying inside infested granaries. The larva of this moth does serious damage to stored grains by boring inside and turning them into chaff. This insect is chiefly a pest of stored grains, but it has also been reported to attack developing grains in the field in the case of wheat, maize, barley, oats, etc., in other countries. Fletcher (1921) mentions that it occasionally occurs in

the field on ripe ears of paddy and cholam. Puttarudriah and Raju (1953) have reported the occurrence of this insect on earheads of cholam in the field at Mysore.

Recently during June and July 1958 this pest occurred in a serious form on standing crop of cholam (*Sorghum vulgare*) and Ragi (*Eleusine coracana*) at the Central Farm attached to the Agricultural College & Research Institute, Coimbatore damaging the ears of both the crops. The earheads were found to harbour a good number of caterpillars which were noticed tunnelling and feeding on the ripening grains. Attacked earheads were reduced to a powdery mass of damaged grains and frass. This kind of damage was found in a large area in the Central Farm and also in the neighbouring ryots' fields and the average yield was thereby considerably reduced in this locality. The occurrence of this pest in such a serious form in a standing crop was rather very unusual in this locality, as it had not been noted till recently as infesting any cereal in the field in this locality. Further it appears it is the first time that this pest is recorded on Ragi on which it has not been recorded before either in the field or in store.

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Coimbatore, S. VIJAYARAGHAVAN,  
October 15, 1958.

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#### NOTE ON SOME CHROMOSOME NUMBERS IN GRAMINEAE

THE haploid chromosome numbers of seven genera and ten species belonging to the tribes *Andropogoneae* and *Panicaceae* are reported in this note. The young panicles were fixed in propionic alcohol and the fixed anthers squashed in propionocarmine to study the meiosis. The chromosome numbers are tabulated in Table I.

The meiosis in all the species was normal forming regular bivalents except in *Themeda triandra* and *Pennisetum squamulatum*. Assuming the basic number of *T. triandra* to be  $x=10$ , the plant with  $n=40$  should be regarded as an octoploid and should be expected to reveal multivalents during meiosis. Yet it was observed to form usually one quadrivalent and 38 bivalents. *P. squamulatum* with  $n=27$ , which is a hexaploid of the basic number 9,

TABLE I

| Species   | Source                           | Chromosome<br>number<br><i>n</i> | Previous<br>report<br><i>2n</i>                              | Author                        |
|---|----------------------------------|----------------------------------|--|-------------------------------|
| <b>ANDROPOGONEÆ</b>   |                                  |                                  |  |                               |
| <i>Themeda cymbaria</i> Hack.   | Ponmudi,<br>Travancore           | 10                               |  |                               |
| <i>T. triandra</i> Forsk.   | Botanic Gardens,<br>Coimbatore   | 40                               | 80   | Celavier and<br>Harlan, 1954  |
| Do.   | Adoni Hills,<br>Kerala State     | 10                               | 20, 22, 30, 40, 45,<br>49, 50, 51, 53, 54,<br>56, 60, 68, 71 | Pienaar, 1955                 |
| <i>Chrysopogon zeylanicus</i> Thw.                                    | Anamalai Hills,<br>Coimbatore    | 10                               | 20   | Darlington and<br>Wylie, 1955 |
| <i>C. asper</i> Heyn.   | Marudamalai<br>Hills, Coimbatore | 10                               |  |                               |
| <i>C. verticellatus</i> Trin.   | Siruvani Hills,<br>Coimbatore    | 10                               |  |                               |
| <i>Ischamum petiolare</i> Hack.                                       | Anamalai Hills,<br>Coimbatore    | 10                               |  |                               |
| <i>Pseudosorghum<br/>fasciculare</i> A. Cam.                          | Anamalai Hills,<br>Coimbatore    | 10                               |  |                               |
| <b>PANICEÆ</b>  |                                  |                                  |  |                               |
| <i>Pennisetum squamulatum</i> Fresen.                                 | Kenya                            | 27                               |  |                               |
| <i>Panicum maximum</i> Jacq.  | Yercaud Hills,<br>Salem.         | 18                               | 18, 32, 36, 48   | Do.                           |
| <i>Stenotaphrum glabrum</i> Trin.<br>(= <i>S. dimidiatum</i> Brongn.) | Travancore                       | 18                               |  |                               |

formed one quadrivalent and 25 bivalents during meiosis.

The authors are grateful to the Systematic Botanist and Professor of Botany, Lawley Road, for the supply of live plants of *Themeda triandra*.

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### PARAFILARIASIS IN BUFFALOES CAUSED BY *PARAFILARIA SAHAI*, N. Sp.

AMONG the skin affections of Indian domestic animals of helminthic origin, those caused by *Parafilaria* Yorke and Mapleson (1926) are widespread. Four species of the genus are already known, viz., *P. multipapillosa* (Condamine and Drouilly, 1878) in equines, *P. bovicola* Tubangui (1934) in cattle, *P. antipini* Rukhliadev

(1947) in deer (*Cervus elephas*) and *P. sp.* Ramanujachari and Alwar (1954) in elephants. These parasites are host specific, and produce in the hosts subcutaneous nodules which come up to the surface, burst, bleed to discharge the larvæ in the oozing blood and the wounds then heal up. The infection among cattle is the commonest occurring throughout the country, specially during the summer months.

Last year, Lt.-Col. P. D. Saksena, Officer-in-charge, Central Military Veterinary Laboratory, Lucknow, reported that a large number of buffaloes at the Military Buffalo Farm, Namkum, Bihar, were suffering from cutaneous bleeding in all parts of the body. In about a week's time where bleeding had taken place, a large abscess formation was seen which in course of time sloughed leaving large sores. The formation of abscess might possibly have been due to secondary infection. No abscess formation has been observed by Alwar and Lalitha (1958) in the case of parafilariasis in a buffalo bull reported by them. It was reported by Lt.-Col. Saksena that on squeezing the abscess, a worm  $\frac{1}{4}$ " to  $\frac{1}{2}$ " in length was pressed out. One such specimen was received from him in the Division of Parasitology, I.V.R.I., Izatnagar, which on examination was found to be a bit of the anterior portion of a female filarid worm belonging to the genus *Parafilaria*. But it could not be assigned to any of the known species

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because of, among other characters, the difference in the cuticular adornment at the anterior end. The roundish cuticular tubercles or papillæ-like structures at the anterior end of this parasite occur in about ten transverse series and extend to a distance of about 50 microns from the anterior extremity. In *P. bovicola* such series of tubercles are far fewer in number and never extend beyond a distance of about 25 microns, though isolated tubercles may occur further back. In *P. antipini* also the roundish tubercles are fewer in number. In *P. multipapillosa* such tubercles occur in 13-15 series and extend to a length of 200-250 microns from the anterior extremity (Metianu, 1949). This parasite also differs from *Parafilaria* sp. from elephant reported by Ramanujachari and Alwar (1954), a photomicrograph of which has been published by Alwar & Lalitha (1958), in the position of the vulva which is, as apparent from the photomicrograph, situated much farther back. The reported occurrence of *P. bovicola* in buffalo as revealed by the presence of similar microfilariae in oozing blood from a cutaneous nodule (Alwar and Lalitha, 1958) needs confirmation by study based on adult parasites. The parasite is therefore assigned tentatively to a new species, *Parafilaria sahaii*, named in honour of Mr. L. Sahai, Animal Husbandry Commissioner with the Government of India, to whom the authors are grateful for much kind encouragement in their researches.

H. D. SRIVASTAVA.  
S. C. DUTT.

Division of Parasitology,  
Indian Veterinary Research Institute,  
Izatnagar, September 20, 1958.

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# ON THE OCCURRENCE OF *FIERASFER* (CUVIER) *HOMEI* AS A COMMENSAL INSIDE THE BIVALVE, *\*PTERIA LOTORIUM* LAMARCK†

THE underwater exploration, by Aqua-lung diving, off the coast of Tuticorin brought to light the existence of the bivalve *\*Pteria lotorium* in considerable numbers at 14 fathoms depth. This is the first record of the above species in Indian waters. A few of these bivalves were kept under observation in the laboratory. As the shell valves of the animal opened agape, an 'elver' like fish was found writhing inside the mucus mass of the branchial region of each bivalve. The movement of the fish resembled that of a 'pipe-fish'. In shape the fish resembled the Eel or 'conger', but stouter in comparison with its length and also more compressed, the form becoming more slender towards the caudal region. The overall length of the fish was 85 mm. The various morphometric features of the fish and the vertebrae counts taken, after subjecting the fish to "Alizarine" technique agreed on broad points with those of the only fish described by Day (1884) under the Family Ophiidae although there were minor points of dissimilarity. It is stated by Day that *Fierasfer homei* is the only species recorded in Indian waters occurring as a commensal or 'free-mess-mate' inside the respiratory process of Holothurians. It is quite likely that in the present case also the fish occurs as a commensal inside the bivalve *Pteria lotorium*, preying on organisms entering the shells along with the current or on those which form the 'Epi-fauna' of the bivalve shells which may creep down or wander into the cavity of the shell valves. The fact that all *Pteria* which were brought out from different places were seen to contain one fish of the species above described rules out the possibility of the fish having gone in accidentally.

Marine Biological Station, S. MAHADEVAN.  
Tuticorin, October 28, 1958.

1. Day, *Fauna of British India*, 1889, **2**.

\* I am thankful to Dr. S. T. Satyamurthy, Madras Govt. Museum, for having kindly identified the Bivalve.

† Published with the permission of the Director of Fisheries, Madras.

## POINTS FROM LETTERS

***Chenopodium* and *Lecanthus* as Test Plants for Potato Viruses**

Messrs. B. Ganguly and M. L. Khanna, Central Potato Research Institute, Simla, write that while studying for the host range among the prevalent weeds of Simla Hills for different potato viruses, it was observed that *Chenopodium album* Linn. could be infected artificially with potato virus X and *Lecanthus wallichii* Wedd. and *L. wightii* Wedd. with both potato viruses X and A by simple sap inoculation technique with carborundum as an abrasive.

On *C. album* the symptoms of virus X first appear on the lower leaves of the plant after 20 to 25 days of inoculation as very small chlorotic spots surrounded by more pronounced concentric chlorotic rings. As the plant grows the concentric rings disappear and the chlorotic spots become more pronounced. With the growth of the plant the symptoms extend to the upper leaves and advance gradually up to the apical leaves, while the older infected ones slowly become yellow and wither away. In the case of the plants of *L. wallichii* and *L. wightii* both the potato virus X and A exhibit similar symptoms on these weeds. Faint vein-clearing symptoms first appear on the leaves of these plants after 9 to 12 days of inoculation. As the plant grows the vein-clearing is followed by uniform interveinal mosaic symptoms. Symptoms may be masked with the rise of temperature in all the three cases when the plants act as symptomless carriers for the respective viruses.

**Occurrence of *Colasposoma metallicum*, CLK, on Sweet Potato**

In the course of investigations on the insect pests of sweet potato crop (*Ipomoea batatas*) the author, Sri. T. R. Subramanian, Division of Entomology, Agricultural College and Research Institute, Coimbatore, noted a heavy incidence of the beetle *Colasposoma metallicum* Clk. (Eumolpidæ) on this crop grown in the Central Farm of the Institute, during the months of September and October 1958. This active shiny metallic green beetle measuring about 7.5 mm. in length was seen in large numbers damaging

the leaves of the crop by cutting numerous shot holes on the leaf surface. The damage was severe and the whole crop occupying an area of about an acre was found infested. This insect has been recorded as a pest on sweet potato at Java (Franssen, C. J., Korte. Meded. Inst. Plaziekt, 1934, No. 20, 21; Rev. Appl. Ent., 1935, 23, 264), but has not been so far reported occurring as pest on sweet potato or any other crop in this locality. Incidentally, this insect was also found to damage the plant *Ipomoea carnea* which has been newly introduced as a green manure crop in this tract.

**A Teratological Phenomenon in *Annona squamosa* L.**

Sri. S. N. Singh, Horticultural Research Institute, Saharanpur, reports that recently, in a seedling of *A. squamosa* L., a pair of sessile leaves were noticed oppositely borne in a stem branch possessing four leaves in all and the leaves of the other branch exhibited normal distichous, alternate phyllotaxy.

The Abnormal branch showed that the petioles of the third and fourth leaf were modified into sheaths and fused together, giving the appearance of two sessile leaves oppositely borne. The growing tip of the branch was subsequently inactivated and remained as a dormant bud in the axil of the two sessile leaves.

**Diploid Chromosome Numbers of Two Wild Plants**

Sri. S. L. Basak, Department of Agriculture, Calcutta University, reports for the first time the diploid chromosome numbers of *Sida humilis* Willd. and *Justicia gendurossa* Linn. f. as 16 and 28 respectively. *Sida humilis* is a trailing herb in India. Hooker says it is variable. This plant is erect and came from South Africa.

**Fruit Rot of *Coccinia indica***

Sri. S. N. Kulkarni (Agricultural Research Institute, Gwalior) reports a fruit rot of *Coccinia indica* caused by *Phythyum aphanidermatum* from Gwalior.

## REVIEWS

**Tauberian Theorems.** By H. R. Pitt. (Oxford University Press), 1958. Pp. x + 174. Price Rs. 22-50.

This book, the second in the series of Monographs on Mathematics and Physics of the Tata Institute of Fundamental Research, presents a neat well-motivated account of the theory developed by Hardy, Littlewood and Wiener between 1910 and 1933, out of a hint dropped by Tauber in 1897, and enriched by the author's own contributions since 1938. The book, based mostly on these contributions, is bound to be of interest to a wide class of readers including research workers, as the following chapter-wise summary of its contents may serve to indicate.

$$(*) \quad g(x) = \int_{-\infty}^{\infty} k(x, y) s(y) dy$$

be a convergence-consistent or regular transformation of  $s(y)$  into  $g(x)$ , said to make  $s(y)$  summable to a finite value  $A$  as  $y \rightarrow \infty$  whenever  $g(x) \rightarrow A$  as  $x \rightarrow \infty$ . Then the author's tauberian theorems are assertions about a certain asymptotic behaviour (in particular, convergence) of  $g(x)$  being linked to a similar behaviour of  $s(y)$ , for summability methods with suitable kernels  $k(x, y)$  applied to functions  $s(y)$  satisfying a condition  $T$  which is called tauberian and can assume various special forms. After an introduction and a chapter on 'elementary' tauberian theorems whose proofs do not involve any preliminary transformation of the kernel, the author proceeds, in Chapter III, to generalize the classical tauberian theorems for Riesz, Abel and Borel summabilities, defining these summabilities via  $(*)$  with kernels of the standard form  $k(X)$ ,  $X = x - y$ , in the first two cases and a kernel of approximately this form in the last case. The generalizations, obtained by the use (novel in the case of Borel summability) of linear combinations of translations of  $k(X)$ , are oscillation theorems, with conclusions of the form

$(**) \quad S \leq c + CG,$   
 $S = \limsup |s(y)|, G = \limsup |g(x)|,$   
 where  $c, C$  are positive constants of which  $c$  is arbitrary while  $C$  depends on  $c$  and the condition  $T$ . Chapter IV on Wiener's theory presents, as a basic theorem, one which extends the conclusion  $(**)$  to a general summability method defined in terms of  $(*)$  with a standard

kernel  $k(X)$  whose Fourier transform is non-vanishing. This theorem is shown to have a counterpart for certain approximately standard kernels, and applications are made to various special summability methods. In Chapter V, there are general mercurian results, including Mercer's theorem in integral form and showing that we can solve for  $s(x)$  the integro-differential equation

$$g(x) = \int_{-\infty}^{\infty} s(x-y) dk(y)$$

when we restrict  $k(y)$  suitably and assume  $s(x)$  to satisfy an order condition (as distinct from a tauberian condition) or even no such condition, the solution in certain cases leading to the relation  $S \leq CG$  in the notation of  $(**)$ . The final chapter proves the prime-number theorem, by the tauberian-type Landau-Ikehara theorem, by the classical tauberian theorem for either Lambert or Ingham summability, and by A. Selberg's famous method. It concludes, opening a promising field of inquiry by expressing the idea behind Selberg's proof thus: if

$$g(x) = s(x) + x^{-1} \int_1^x s(x-y) dk(y) \rightarrow 0 \text{ as } x \rightarrow \infty,$$

then  $s(x) \rightarrow 0$ , provided that  $k(y)$  satisfies certain conditions and  $s(x)$  certain others expressible in a familiar tauberian form.

Of special relevance to the foot-note to page 92 is a paper by W. Meyer-König and K. Zeller [*Math. Zeit.*, 66 (1956/57), 203-224] not mentioned in the Bibliography. Noticeable defects in typography are broken types, the misprint  $x(0)$  for  $x(1-0)$  in the first line of page 126, the misprint (3.4.7) for (3.4.8) in line 16 of page 41, and the marginal misalignments of line 18 of page 30 and line 5 from the bottom of page 169.

C. T. RAJAGOPAL.

**Behind the Sputniks.** By F. J. Krieger. (The Rand Corporation, Public Affairs Press, Washington), 1958. Pp. 377.

The successful launching of Sputnik I by Russia on October 4, 1957 marked the beginning of a new era in the history of man's quest to probe into the fathomless depth of our universe. This was followed by Sputnik II a veritable laboratory with a living individual, weighing nearly a ton. A remarkable victory was scored

by Russian scientists on the eve of the new year 1959 when they shot a rocket into space which escaped earth's gravity and travelled beyond the moon to become the first artificial planet, of the solar system. All these achievements took many a nation engaged in similar pursuits by surprise and this unprecedented human victory has been possible and, indeed is the culmination of painstaking and calculated research programme, to the success of which the early Russian pioneers, among whom particular mention may be made of K. E. Tsiolkovskic, contributed in no small measure.

The book under review is a survey of Russian work in the field of astronautics and the material is presented in the form of 39 articles which are translations from contributions by Russian specialists, concerned with problems of space flight and the associated technical development. The book begins with an introduction in which a brief historical account of Soviet interest in the field of astronautics up-to-date is dealt with. The articles are grouped under the following seven headings :

Space Flight Comes of Age ; Problems of Astronautics ; Biological Factors ; Lunar and Cosmic Projects ; Rocket and Missile Developments ; Satellite Plans and The Sputnik.

A survey of the material presented in the volume is bound to convey even to a layman an intelligent appreciation of this highly complicated subject and how the Russian scientists with their characteristic persistence have solved many of the intricate problems.

Creation of artificial satellites, interplanetary travel and probing the more distant space were thought of as unrealisable dreams. The successes in these fields have been due to the development of suitable engineering materials having exceptional properties, fuels of novel kinds and finally the electronic control systems. The interest in the creation of artificial earth satellites has been stimulated by programmes for the study of the upper air during the International Geophysical Year. Indeed, the day may not be far off when homosapiens could set their foot on planets and possibly return to earth alive.

At the present stage when the world's attention is focussed on the Russian achievements in this field and when the knowledge available is practically next to nothing, the book under review, written in a popular style would be welcomed by one and all.

A. J.

The Indian Ephemeris and Nautical Almanac for 1959. (Published by the Manager of Publications, Civil Lines, Delhi), 1958. Pp. xxiv + 404. Price Rs. 12-00 or 19 sh.

We had occasion to review\* the first issue of this Ephemeris for 1958. The present issue follows generally the same arrangement as the previous one and the few changes introduced, are indicated on p.v of the Preface. In particular, the explanations have been made more exhaustive wherever necessary, and this has made many of the tables more valuable.

We think that it has also been a wise policy not to follow the decision of the several foreign national ephemerides to discontinue publication of the apparent places of the fundamental stars from 1960 onwards, but to restrict oneself to the inclusion of only a small number of important stars. Thus one finds in the present Ephemeris the apparent places of only 68 such stars. It is interesting to find that in the tables relating to mean places of stars, the Sanskrit names are indicated in the footnotes wherever possible, and that 19 out of the 68 stars, whose apparent positions are given, find a place in Indian Astronomy.

Few other minor improvements may also be noted. The two tables relating to conversion of arc to time and vice versa have rightly been placed before the table of interpolation coefficients. In the tables which relate to the Indian Calendar, the footnotes to the second table corresponding to each month contain data regarding the moon's entry into the several zodiacal signs, and this is bound to be useful to almanac-makers in the country.

In our review of the first issue, we expressed our disappointment at not finding a single letter of the Sanskrit alphabet anywhere in the whole volume. It is therefore gratifying to note that under the heading of Symbols on p. 402, the names of the Sun, Moon and the Planets are given in Sanskrit, and also in the transliteration of the Sanskrit alphabet Devanagari letters are used.

There is no doubt that this second issue is a definite improvement over the first, and we hope that in future editions more deficiencies will be made good, thus making the Indian Ephemeris and Nautical Almanac a vital factor in the advancement of astronomical studies in India.

B. S. M.

\* *Curr. Sci.*, Oct. 1957, 26 (10), 312.

**Advances in Petroleum Chemistry and Refining, Vol. I.** Edited by Kenneth A. Kobe and John J. McKetta, (Jr.). (Interscience Publishers, New York), 1958. Pp. 641. Price \$13.50.

Crude oil and natural gas have played a major role in the rapid economic progress of the twentieth century. The advances which are being made by the petroleum and petrochemicals industry need authoritative recording. With this aim in view, the editors have, in Vol. I, presented a series of critical evaluations of new developments in this field, contributed by leading authorities. The volume is divided into five sections:—Economics and future trends, Unit operations and Design, Refining processes, Petrochemicals, and Mechanical equipment. Each main section is subdivided into chapters to provide some perspective and a better understanding of the size and structure of this growing industry.

Section I deals with the complexity and problems involved in the basic operations of exploration and production of oil and natural gas and the trends of expansion in petroleum industry, in the United States in particular. Section II deals with improved separation processes coupled with the nearly untouched potentialities of crystallization and their results. It also gives an account of special features in the design of an extractive-distillation column and discusses the comparative merits of various types of New Fractionating-tray Designs. Section III discusses the need for modifying the refinery operations to provide the fuel for future engines and gives an account of catalytic reforming and solvent refining. Section IV deals with information regarding Oxo-operation and Oxo-plants of which there are currently five in operation in the United States. The principal commercial use of Oxo-process in U.S. is to make  $C_8$  and  $C_{10}$  isomeric alcohols. This section also explains the production of solid polymers with specific molecular structure as a result of the development of new surface catalysts. In Section V, an attempt has been made to forecast the trends in new power plant developments and to evaluate the evolving changes in the older types. At no time in automotive history has there been such wide exploration of new ideas for power production. Hence in this section there is a major emphasis on the trends in automotive power plants utilising petroleum products for fuels and lubricants.

The book gives a connected account of recent advances of petroleum chemistry, refining and critically evaluates the future possible industrial developments in the science of petroleum.

It has taken the fundamental knowledge of chemistry and chemical engineering and transformed itself from a simple processing industry for fuels and lubricants to an extremely complex chemical process industry. This edition is very well brought out and the editors deserve to be congratulated in their choice of leading authorities as contributors, with the signal purpose of popularising a complex and dynamic industry, such as petroleum.

S. BALAKRISHNA.

**Drycleaning: Technology and Theory, A Report of the National Institute of Drycleaning.** By Albert R. Martin and George P. Fulton. (Interscience Publishers, Inc., New York), 1958. Pp. viii + 269. Price \$6.00.

This monograph presents an up-to-date survey of our knowledge of the field of detergency, both aqueous and non-aqueous. It is set out in twelve chapters, the first of which describes very briefly drycleaning fluids, solvent reclamation, equipment used, drycleaning detergents and the colossal volume of drycleaning sales which was estimated at \$1,750 million for the year 1956. The second chapter which deals with the soiling of fabrics presents a concise account of various types of natural soils derived from various sources along with their chemical compositions, particle sizes and physical and chemical characteristics. The considerations governing the formulation of a model artificial soil as well as its application to fabrics and the methods of measurement of the degree of soiling are also expounded in this chapter. The succeeding four chapters deal respectively with the detergent process in aqueous systems, the mechanism of soil removal in drycleaning, and selection of drycleaning solvents. Chapters VI and VII discuss the merits of the various types of drycleaning detergents based on soap and the synthetic drycleaning detergents, along with methods for their evaluation. The colloid chemistry of non-aqueous solutions, formation of micelles in non-aqueous solutions, the important role played by water in the drycleaning bath, the practical application of the electrical conductivity data are all discussed in Chapters VIII, IX and X respectively. The last two chapters present the scientific basis of garment finishing and the physical effects related to finishing. These include a resume of the theories regarding the effect of water as well as of heat on textiles, the mechanical properties of textiles, creasing, wrinkling and shrinkage as

well as other physical changes in garments caused by improper finishing (pressing).

While this book cannot be considered to be a manual of drycleaning, it fulfils admirably its avowed object, namely, to assist all technologists engaged in researches in the field of detergency. The book cites copious references which are well indexed. The printing and get-up are excellent.

K. R. K.

#### General and Inorganic Chemistry. Third Edition.

By J. R. Partington. (Macmillan & Co., Ltd., St. Martin's Street, London W.C. 1), 1958. Pp. xxiv + 927. Price 60 sh.

Brought out in excellent print and with very good diagrams, Professor Partington has once again given to students of Chemistry another edition of his popular book. A large amount of new matter has been introduced in this edition, which very clearly stress the fields of research activity going on in chemistry. While treating the hydrides of boron the author has given a very brief and useful description of the now commercially manufactured materials, the metallic borohydrides. The alkyl diboranes and the borines have also been described. The much needed inclusion of the chemistry of the rare earths is to be greatly appreciated. The author has unfortunately not given the necessary prominence, in this section, to the "lanthanide contraction" (p. 436-I) and treating the chemistry from this principle which is undoubtedly 'one of great importance in the increase of our knowledge of the connection between atomic structure and the properties of elements'. Also, whatever pleas Professor Partington may give regarding the plan of his book, the reviewer feels that the "Inert Gases" certainly deserve a separate chapter to themselves.

In the highly condensed 'General Chemistry' part of the book the author with great dexterity has introduced the very important facts pertaining to the "packing fraction", also the paragraphs on Nuclear Chemistry have been largely increased and extended, and these have given the sections of "Radio-activity" and "Isotopes a completeness".

Apart from the 927 pages in conformity with the pagination in the previous edition, about 70 pages of entirely new and latest material have been incorporated in the body of the book. They deal with our further knowledge regarding Francium, Boron Hydrides, Rare Earths, Photosynthesis, Thorium, Nitronium compounds, Niobium, Tantalum, Polythionates and Sulphur

nitrides, Technetium, Polonium, Transuranic Elements, Structure of Metal Carbonyls and the theories of metals and of complex ions.

Regarding the 'impurities' or 'abnormal states' attributed to diamond in discussing its structure (p. 440), the reader is, however, strongly recommended to refer to the proceedings on the Symposium on Diamond published in the *Proc. Ind. Acad. Sci.* 1944, 19 A, 189-432. It is felt that the disposition of Fig. 25 (p. 49) illustrating Perrin's experiment on Brownian movement is not according to convention and is likely to mislead the unwary student.

A reading of this book will give a student the much-desired highly co-ordinated picture of the subject and many of the references provide very good and simple introduction to research papers. It will serve as an ideal text-book for the 3-year degree course now introduced in the Indian Universities.

G. B.

**Scientific Glass Blowing.** By E. L. Wheeler. (Interscience Pub., New York), 1958. Pp. xxii + 478. Price \$ 9.75.

The variegated experience of the author in the field of glass blowing and in general laboratory practice has impelled him to present the subject-matter under review from a new standpoint.

Simple operations in glass blowing are described in the beginning with numerous illustrative diagrams. A vast field in scientific glass blowing including the manufacture of many precision and complicated apparatus are described in an easy-to-follow way. In addition to this, the author has devoted a good portion of the book in presenting various other laboratory techniques such as lathe work, coating of glass and metal surfaces with thin metal films, vacuum technique, purification of mercury, etc. A good knowledge of these techniques will be very useful to glass blowers particularly to those who are attached to research organisations.

Making ground glass joints—glass-to-glass joints and glass-to-metal joints—is indeed one of the major items of work a laboratory glass blower has to handle. A lengthy chapter is devoted to the description of the various steps and procedure involved in the manufacture of these. Ample illustrative diagrams and photographs of tools and machines used in different operations make the book interesting.

Tables and many other useful information given at the end of the book will come in very handy for reference.

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The simplicity of approach adopted makes the utility of the work still greater, as even a beginner will find the complexities explained in a manner understandable to him. The reviewer would unhesitatingly recommend this book to every laboratory technician and research worker who have to deal with glass apparatus.

K. T. BALAKRISHNAN,

**Animal Disease and Human Health.** (*Annals of the New York Academy of Sciences*, Vol. 70, Art. 3, June 1958. Pp. 277-762.)

Like every one of the annals of the Academy this volume of about 500 pages is authoritative. In eight parts are found the various papers presented at a Conference on Animal Disease and Human Health organised by the New York Academy of Sciences in collaboration with the Communicable Diseases Centre, Public Health Service, during September 1957.

A general idea of the problem can be had by reading Martin's Introduction in the beginning and Schuman's Summary at the end of the Volume.

To us, in India, the chances of human beings acquiring diseases from their animal contacts are really much more on account of the generally bad environmental conditions and the greater intimacy between man and animal, especially cattle. The Arthropod-borne Encephalitides are only now being studied though in a small way in India. The Kyasanur Forest Disease, a febrile disease with hemorrhagic complications has recently arrested the attention of the Indian Council of Medical Research. But there are no data regarding the large number of sporadic cases of Encephalitis seen all over the country.

Rabies has been discussed in Part IV. The prevalence of the infection in bats, the development of chicken embryo vaccine and the possibility of inducing passive immunity by injections of hyperimmune anti-rabies serum should interest all Indian workers. Undoubtedly the extent of the rabies problem in India is much more than in the United States.

Salmonellosis is apparently on the increase in India and requires more intense study.

Physicians and veterinarians will alike be interested in this extremely informative book. The problems connected with Animal Disease and Human Health in India are in many ways different from what they are in the U.S.A. It will be most interesting and useful if the Indian Council of Medical Research can organise a conference similar to the one which forms the

basis of this volume and focus the attention of Indian workers on local issues.

K. S. S.

#### Books Received

*Cytology and Cytogenetics.* By Carl P. Swanson. (MacMillan & Co., St. Martin's Street, London W.C. 2), 1958. Pp. x + 276. Price Rs. 7-50.

*Principles of Statistical Techniques.* By P. G. Moore. (Cambridge University Press, London N.W. 1), 1958. Pp. viii + 239. Price 22 sh. 6 d.

*The British Journal of Psychology—Figural After-Effects.* By Peter McEwen. (Cambridge University Press, London N.W. 1), 1958. Pp. vii + 106. Price 22 sh. 6 d.

*Advances in Clinical Chemistry*, Vol. 1. Edited by H. Sobotka, C. P. Stewart. (Academic Press, New York-1; India: Asia Publishing House, Bombay-1), 1958. Pp. xi + 308. Price \$ 12.00.

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*Surgical Convalescence.* By F. C. Dohan and others. (*Annals of the New York Academy of Sciences*, Vol. 73, Art. 2.) Pp. 381-538.

*Phosphorus and its Compounds*, Vol. 1. By J. R. Van Wazer. (Interscience Publishers, New York), 1958. Pp. xiii + 954. Price \$ 27.50.

*Genetic Concept for the Origin of Cancer.* By L. C. Strong and others. (*Annals of the New York Academy of Sciences*, Vol. 71, Art. 6.) Pp. 807-1241.

*Basic Biodynamics.* By E. J. Kempt and others. (*Annals of the New York Academy of Sciences*, Vol. 73, Art. 4.) Pp. 869-910.

*Contributions of the Physical, Biological and Psychological Sciences in Human Disability.* By R. Contini and others. (*Annals of the New York Academy of Sciences*, Vol. 74, Art. 1.) Pp. 1-160.

*The Basic and Clinical Research of the New Antibiotic, Kanamycin.* By Maxwell Finland. (*Annals of the New York Academy of Sciences*, Vol. 76.) Pp. 17-408.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

The Andhra University has awarded the D.Sc. Degree in Mathematical Physics to Sri. I. V. V. Raghavacharyulu for his thesis entitled "Representations of Space Groups", and D.Sc. Degree in Physics to Messrs. S. Paddi Reddy and I. Achyuta Rao for their theses entitled "Studies in the Electronic Spectra of Certain Diatomic Molecules" and "Spectroscopic Investigations on some Disubstituted Benzenes and Carbonate Compounds" respectively.

The University of Poona has awarded the Ph.D. Degree in Physical Chemistry to Sri, D. N. Sitharamarao for his thesis entitled "Diffusion of Ions in Solution".

### Application of Atomic Energy to Agriculture (Radio-isotopes and Grants-in-aid available)

In order to promote the application of atomic energy to food and agriculture, the Department of Atomic Energy will supply radio-isotopes and other equipment to scientific workers in universities and other institutions. Grants-in-aid will also be available for those engaged in investigating the use of atomic energy in agriculture, food processing, animal husbandry, fishery, forestry, and allied subjects.

All applications in this connection would be preferred to a ten-member Advisory Committee presided over by Dr. B. P. Pal, Director, Indian Agricultural Research Institute, New Delhi. This Committee, besides advising the Department on the subject of grants-in-aid and supply of radio-isotopes and other equipment, would also encourage and advise research institutions, universities and other organisations in the use of atomic energy in agriculture and food processing.

Besides the Chairman, the Committee consists of the following members : Dr. A. R. Gopal Ayengar, Sri. B. K. Chougule, Dr. E. K. Janaki Ammal, Dr. V. N. Patwardhan, Dr. S. V. Pingale, Dr. S. Pradhan, Sri. A. S. Rao, Dr. M. S. Swaminathan, and Dr. K. C. Bora, Atomic Energy Establishment, Member-Secretary. (Press information Bureau, Govt. of India, Bombay).

## TheACHEMA 1961, 13th Exhibition Congress

The above Exhibition Congress of Chemical Engineering organised by the DECHEMA will be held in Frankfurt a.M. from 9th to 17th June 1961. It will once again include the follow-

ing groups of exhibits : Research and literature, New chemical substances, Nuclear science and techniques, Laboratory ' techniques, Measurement control and automation techniques, Structural materials techniques, Works techniques, Pumps and fittings, Packing techniques, Auxiliary materials and consumable stores, Accident prevention and works safety precautions.

**International CIB Congress 1959, Rotterdam,  
21-25 Sept.**

On the occasion of its third General Assembly in 1959 the International Council for Building Research, Studies and Documentation, C.I.B. will organise an international congress open to C.I.B. members and their representatives, as well as to other interested experts.

The principal object of the congress will be to widen the horizon of experts by presenting to them important building research and building documentation problems and results. The subjects will be introduced by leading experts from various countries and subsequently put up for discussion. The subjects relate to theoretical and applied building research and to building documentation and transmission of knowledge. In addition, attention will be given to some special aspects of building in tropical countries.

The congress subjects will be introduced in plenary sessions, and will be continued, if necessary, in parallel sessions. During the plenary sessions of the congress simultaneous translations of the proceedings into English, French and Russian will be arranged.

Provisional application forms are to be completed and sent before 15th April 1959 and can be had from Assistant Director (Information), Central Building Research Institute, Roorkee.

## Hydraulics Research Papers

The Hydraulics Research Station, D.S.I.R., is introducing a new series of research papers. The first two (Resistance of fluids flowing in channels and pipes, price 3 sh. 6 d., and Charts for the hydraulic design of channels and pipes, price 12 sh.) deal with the flow of water in open channels and pipes, and it is hoped that design engineers will find them a valuable reference work.

During the past 200 years the flow of water in channels has been studied extensively and

**Image Intensification**  
A problem of great interest to the nuclear power industry is the reduction of radiation exposure to personnel working in areas where high levels of radiation are present. One solution is the use of image intensification. This is a process by which the light from a scintillator is intensified by a series of electron multipliers, resulting in a much brighter image. This process is used in many applications, including the inspection of welds and the detection of leaks in nuclear reactors. The use of image intensification can significantly reduce the radiation dose to personnel, thereby improving their health and safety.

a large number of formulæ has become available to the design engineer. However, as these formulæ are generally of limited application, designers have experienced difficulty in selecting formulæ appropriate to their requirements and much confusion has been caused. In the 1930's Dr. Colebrook and Professor White working at Imperial College, London, employed the then new theories of turbulence to bring almost all the problems of hydraulic friction within the scope of one equation. This equation is recognised as the best yet devised but unfortunately it has proved to be too complex to be popular with the average design engineer. Attempts have been made in several countries to express it in easily usable form but none was completely successful.

The Hydraulic Research Station has now solved the difficulty by developing the formula so that it can be expressed in graphical form. Paper No. 1 gives this development after fully reviewing and discussing the subject of hydraulic friction. Paper No. 2 contains 28 design charts, based on this development of the Colebrook-White formula, covering a wide range of conditions, materials of construction and cross-sectional shapes for conduits ranging from 80-ft. diameter hydro-power tunnels down to one-inch diameter copper piping. Many examples of hydraulic designs are given in this publication, including an oil pipe line, concrete-lined channels of rectangular and trapezoidal cross-sections and storm drains flowing with a free-water surface.

#### Image Intensification of X-Radiograms by Television

A problem whose solution will be of great interest to radiologists is how to obtain image intensification of X-ray radiograms with a reduced dosage of X-radiation. In diagnostic radiology an X-ray image is usually rendered visible by a fluorescent screen when X-ray energy is converted into light energy (or by a photographic film which, on processing, reveals the latent image). The present method of image intensification is to convert this light image on the fluorescent screen into an electron image. The energy of the electrons is then increased and the image may be focussed with electron lenses and allowed to fall on another fluorescent screen yielding a considerably brighter image than the first one. Alternatively the initial image may be scanned as in television, the resultant electric current being then amplified and viewed on a conventional television screen as an image with increased

brightness. The radiologists, however, is primarily concerned with obtaining a brighter image with less radiation and without significant reduction of definition rather than with achieving merely increased brightness with the same doses of radiation as are used with conventional methods. There are many reasons for wishing to reduce the dose of radiation, the potential hazards being in themselves a cogent one. It seems unlikely that further advances of major importance can be made in this field unless a more efficient means than the fluorescent screen is found for converting the primary X-ray image, for, though image intensifiers may have an intensification factor of hundreds the radiologists can reduce the dose of radiation only by units, if definition is not to be sacrificed. —British Medical Journal, December 13, 1958.

#### Flurotron Camera Reduces X-Ray Exposure Time

Although early stages of a number of serious illnesses can be diagnosed by X-Ray, many people had been reluctant to submit to such examination because of the fear of radiation exposure. Beattie-Coleman's new Flurotron Camera answers the need for a camera lens fast enough to accomplish the desired reduction in radiation hazard.

The Flurotron Camera has an  $f/0.95$  image-flattening lens which reduces X-Ray exposure time to about 40% of that previously required, with improved lens resolution which contributes significantly to diagnostic accuracy. The camera is electrical; pulse-operated; powered by 110-120 V., 50-60 cycle AC; designed specifically for fluorographic recording. The  $f/0.95$  lens is refractive; nine element; 120 mm. The fully automatic magazine accepts up to 100 feet 70 mm. roll film.

Further details are available from Ad. Auriema, Inc., 85 Broad Street, New York 4, N.Y., U.S.A.

#### Household Warning Alarm for Nuclear Fall Out

Tracerlab, Inc., Waltham, Mass., has recently developed a practical, dependable, inexpensive device which can provide every American Family with its own nuclear fall out warning alarm. After alerting the household to dangerous radiation fall out, the device can guide the family to safety.

The new device called the BANSHEE, plugs into any standard radio, or television set and sounds a wailing alarm through the loud speaker when exposed to radioactive fall out in dangerous concentrations.

The 'brain' of the Banshee is about the size of the eraser on a standard wooden pencil and is made of inexpensive components. The device operates only in response to radiation. In AC sets, it will operate as long as power is available. Its full utility is realised however in a battery operated set with an independent power supply which makes it portable. Since it draws no current in the standby condition, it does not drain the batteries.

One of the most important aspects of the device is that with auto or portable home radios it can act as a path-finder to lead survivors out of radiation danger areas. The pitch of the wail rises as the amount of radioactivity increases, and falls as the amount of radiation decreases. By travelling in the direction which causes the pitch of the wail from his portable or automobile radio to fall, a person can escape from a radiation danger zone.

The first working model was successfully demonstrated to Commissioner Willard Libby of the U.S. Atomic Energy Commission in December 1958, who gave his reaction thus: "I am very excited about the possibility of Banshee as a nuclear fall out monitor. I have long urged that such a monitor be made available, and Tracerlab's achievement proceeds in the direction I have outlined on many occasions heretofore". —Tracerlab: News Release.

### Argon Chromatograph

This Pye Chromatograph which uses the new Argon Detector of the ionization type devised by J. E. Lovelock shows one of the recent advances in gas chromatography technique. Argon which is used as the carrier gas is excited into its metastable state on entering the Detector. The excitation energy of argon is 11.6 volts and as this level is higher than the ionization potential of organic vapours, any organic vapours present in the carrier gas are ionized on collision with excited atoms as they enter the Detectors thus causing a considerable increase in current through the cell. Furthermore, the electrons emitted when organic vapour molecules are ionized, are able to enter into the process of producing more metastable or excited argon atoms. Such an effect depends upon cell voltage so that with an increase in voltage greater sensitivities are obtainable. The sensitivity range is approximately one part component in  $2 \times 10^6$  to  $2 \times 10^8$  parts of carrier gas for full scale deflection on the recorder. The limit of detection is one part component in  $2 \times 10^8$  of carrier gas of  $10^{-11}$  moles. Minute samples in the order of 0.1 to 0.025 microlitre

are inserted quite simply by a micropipette. No overloading occurs since a smaller proportion of liquid phase is used: as a result column efficiencies in the order of 1000 theoretical plates per foot length of column are obtainable. A short, high efficiency column gives a much reduced analysis time and increased definition. (Physical Society; 43rd Exhibition of Scientific Instruments.)

### Filter-paper Method of Measuring Flocculation of Suspensions

Prof. R. Fahraeus of Germany, has developed a method for measuring the degree of coagulation present in a blood sample. The procedure is to filter the blood through a stack of filter-papers and to measure the quantity retained on each. This technique has been tried by R. L. Whitmore (*Nature*, January 31, 1959) for measuring the degree of flocculation of shale and clay suspensions. 100 ml. of a 2% suspension (by weight) of a coal-measure shale in distilled water is poured into a pressure filter which contains a stack of filter-papers (Whatman No. 4, 9 cm. diam.) and a pressure of about 15 lb./sq. in. is applied. The experiment is repeated with the suspension after 5 ml. of a 1% solution of potash alum has been added to it in order to produce flocculation of the solid matter. The reduction in the penetration of the filter-papers becomes very obvious. Comparative study of the contents of successive filter-papers should make the method amenable to quantitative measurement.

### Maser Technique in Radio Astronomy

L. E. Alsop et al. report (*Astron. J.*, 1958, 63, 301) the successful application of maser techniques in radio-astronomical observations at the U.S. Naval Research Laboratory. The maser amplifier is a three-level Bloembergen type (see *Curr. Sci.*, 1958, 27, 119) with a 0.1% concentration of  $\text{Cr}^{3+}$  in ruby serving as the paramagnetic medium. The ruby crystal is mounted in a double resonant microwave cavity in liquid helium at  $1.4^\circ \text{K}$ . and in a magnetic field of 3500 oersteds. The optimum signal-to-noise ratio for the system is obtained with a gain of about 20 decibels. The maser is used as a pre-amplifier and is mounted near the focal point of the 50 ft. reflector. The results obtained show an improvement factor of ten in signal-to-noise ratio over the same installation without the maser pre-amplifier. Observations were made of Venus, Jupiter and Nebula NGC 4486.

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### Synthetic Quartz Crystals

The Western Electric Company and the Bell Telephone Laboratories in New York have jointly succeeded in growing large crystals of artificial quartz. It has long been known that small quartz crystals can be developed in silicate solutions by suitable treatment, but in the new process crystals up to 5-6" long and 2-3" cross-section have been obtained. A vertical autoclave is filled with a solution of sodium hydroxide and small pieces of natural quartz are placed in the bottom to serve as material. Seed plates cut from natural quartz crystals are hung from a rack in the upper part of the vessel. After sealing, the autoclave is adjusted to satisfy the severe conditions of temperature and pressure required for the process. A constant temperature differential is maintained from bottom to top during the processing time which may last several weeks. The nutrient material dissolves in the hotter lower region and is carried by convection currents to the cooler upper region, where the solution becomes supersaturated and the dissolved silica is deposited in the form of a single crystal. The crystals produced are free from foreign inclusions, are without optical or electrical twinning and can be sawn in the most efficient manner.—*Nature*, January 31, 1959.

### Researches on Synthetic Rubber

Details of research carried out at the Max-Planck Institute for Coal Research, Mulheim-on-Ruhr, on the use of metallic alkyls in the production of a new type of synthetic rubber were given recently by Prof. Karl Ziegler, at a conference of the German Society for Mineral Oil and Coal Chemistry at Goslar.

Organo-metallic compounds, particularly aluminium compounds, were used as a basis for the experiments. The research was initially concerned with the synthesis of aluminium trialkyl from aluminium, hydrogen and olefins, and with the various uses to which such a product could be put. The alkyls could be used either for catalysing purposes or as auxiliary agents in the production of extra-active organometallic co-catalysts. With the aluminium alkyls, olefins, particularly ethylene, in the low-mole-

cular field could be polymerised. This meant that using ethylene, butylene, hexene, octene, etc., or with propylene or isohexene, a most varied range of materials could be produced.

By the addition to such chemicals as listed above of the aluminium alkyls and titanium compounds it was possible to effect a favourable physical development into the high-molecular range, which made possible the production of any number of quite different types of product. Reaction with catalysts such as the above yielded products such as low-pressure polythene, polypropylene, various types of butadiene-rubber and so on. A catalyst agent of this type had already outside Mulheim, been able to produce what was called 'synthetic natural-rubber' from isoprene. Another organometallic co-catalyst had been found to convert butadiene under cyclic trimerisation into cyclododecatene, a basis for many interesting new compounds, particularly in the field of Perlon-type materials.

The intermediate products were the organo-aluminium compounds used for the production of higher-quality fatty alcohols from ethylene, organic borax compounds and of tetra-ethyl lead (the best known anti-knock medium for motor engines).—*Chemical Age*, December 6, 1958.

### Thickness of Earth's Crust in Antarctica

Antarctica has always been regarded as a continent. A direct method of verifying the continental status of Antarctica is to determine the thickness of its crust, for it is fairly well established that the continental regions have a crustal thickness of 30-40 km. or more, in contrast to thicknesses of 5-15 km. in oceanic regions.

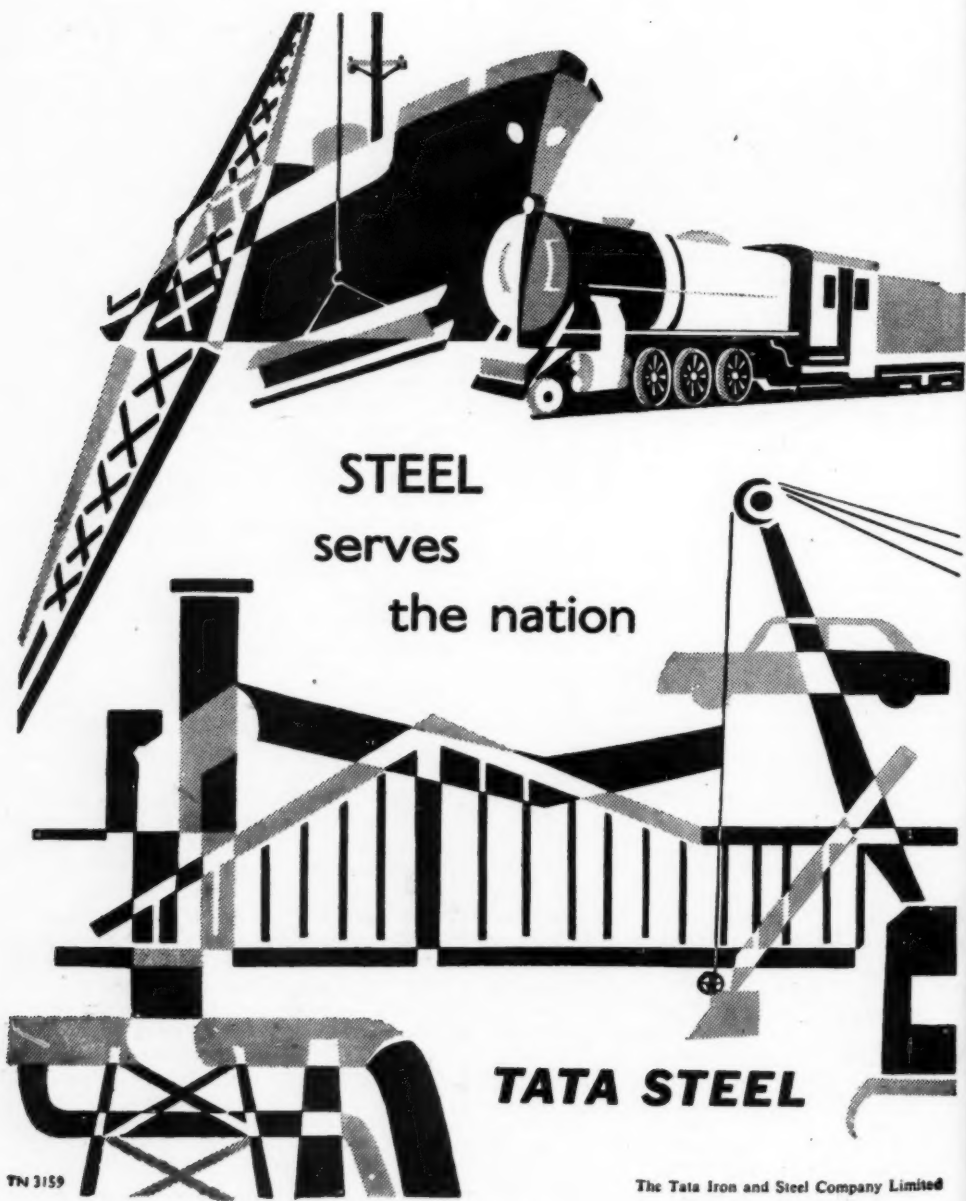
Under the Antarctica Programme of the IGY, the three seismographic stations, Hallet Station (U.S.A.—N.Z.), Scott Base (N.Z.) and Mirny (U.S.S.R.) obtained seismic wave records of the earthquake of September 9, 1957 with epicentre in the South-East Indian Ocean (48° S, 101° E). An analysis of the records has shown that the thickness of the crust in Eastern Antarctica is about 35 km. This confirms the existence of a true Antarctic continent.—*Nature*, January 31, 1959.

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All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

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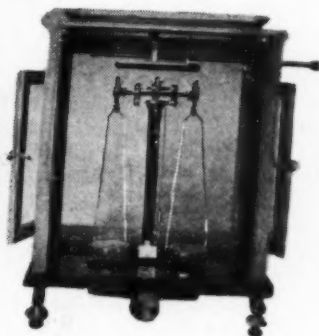
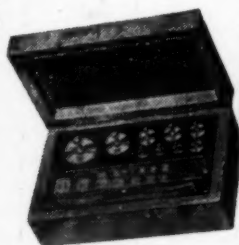
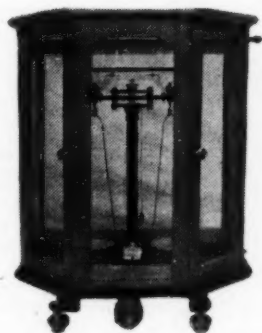
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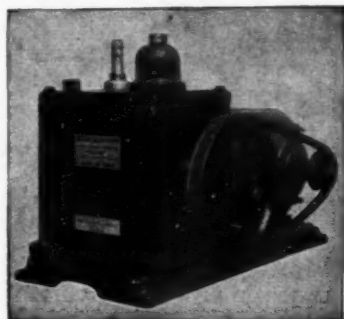
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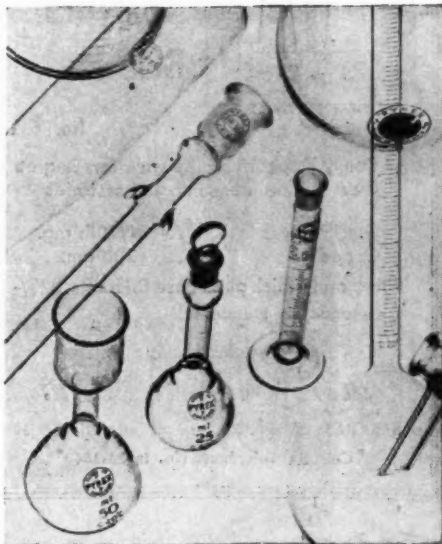
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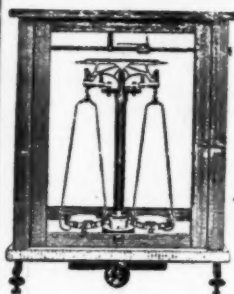
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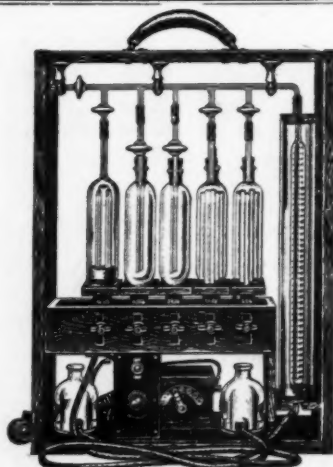
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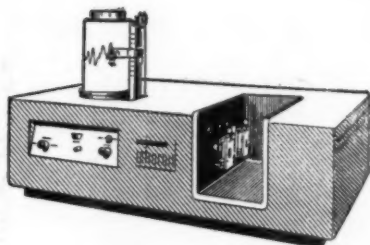
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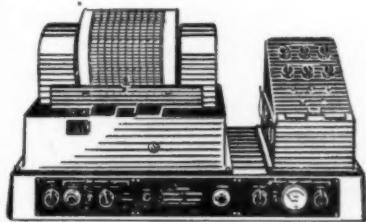
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